SCIENTIFIC AMERICAN SUPPLEMENT No. 656

Scientific American Supplement, Vol. XXVI., No. 656.
Scientific American, established 1845.

NEW YORK, JULY 28, 1888.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THE PANAMA SHIP CANAL.

IN our SUPPLEMENT of last week an account was given of the plan and works of this great constructive enterprise, with some illustrations, which are continued this week. The "Compagnie Universelle du Canal Interocéanique de Panama," founded by M. Ferdinand de Lesseps, at Paris, in 1880, is engaged in making an open canal, at the sea level, without locks, across the Central American isthmus, from the Atlantic shore at Colon (Aspinwall), in the Gulf of Mexico, to the mouth of the Rio Grande, in the Bay of Panama, on the Pacific Ocean side. The entire length of this canal, including a channel to be dredged in the shallow water of the bay, will be not quite forty-six miles; its depth will be 29 ft. 6 in.; its width at the bottom will be 72 ft.; at the top, 131 ft., dimensions rather larger than those of the existing Suez Canal. The only great difficulties in the execution of the work are found in the necessity of erecting an immense dam and diverting the junction of the River Chagres with the Obispo, to prevent their flooding the country between Emperador and Colon; and secondly, in cutting through the range of hills, 360 ft. high at Culebra for one mile, and 200 ft. high at Emperador; the hill region, altogether, covering about nine miles of the route of the proposed canal. It is entirely a question of the amount of cost and labor required for these enormous earthworks; the rest of the work is mainly dredging and digging in comparatively easy ground; and the operations are much facilitated by the aid of the Panama Railway, which has been purchased by the Panama Ship Canal Company. The expenditure already incurred has been more than £46,000,000 sterling, and £24,000,000 will be required to finish the work; but there can be no doubt whatever of its practicability, if money enough can be got to continue the operations a few years longer.

Our special artist writes as follows:

"I am not prepared at this moment to name the seven wonders of the world; but I am certainly disposed to say that the eighth wonder of the world will be the canal which is now being constructed between Colon and Panama, in Central America. I feel that it must in a few years be completed, and it will enable ships of almost any tonnage to pass from the Atlantic to the Pacific Ocean in twenty-four hours. I feel the same as all those who have been over the ground; that it would be a crying shame, even a disgrace, to the world at large, that such a grand undertaking should be allowed to drop. More than half the work is finished, the machinery is on the ground, and is hard at work, in many places by night as well as by day. And when we remember that only half the amount of money already spent is required to complete the work, I repeat, it would be a mistake and universal disgrace not to finish it.

"The town of Colon, on the Atlantic side, is not particularly beautiful or interesting, except for its cosmopolitan character. Three years ago, in 1885, during the last revolution, the original Colon was destroyed by fire, and the new city presents now rather the character of an American town. The houses, wharves, shops, magazines, and even the streets, are wholly constructed of wood. The front street of Colon might almost be said to be unique; half the roadway is taken up by the railroad company; and woe betide the careless driver of a carriage or cart who attempts to cross the street without looking right and left! It is true, the engine stoker rings a sonorous bell all the time the train is traveling in the street; but the ear becomes so familiar with the sound, that at last one is apt to pay no attention to it. I chanced to see a wretched mule which refused to draw a cart with goods any further; he planted himself in the center of the track, in face of an advancing train. Great were the efforts made both to push him on and to stop the train. The railroad track is of wood, and the carriage way, as also the footpath, is of the same material; in fact, everything is made of timber. The town, although not the healthiest in the world, is certainly not nearly so bad as is usually reported; but there is a damp heat, which is truly appalling, and which keeps you in a state of moisture day and night. The people of the town are composed of every nationality in the world, and the costumes, though anything but picturesque, have a variety not to be met with, I believe, in any other place.

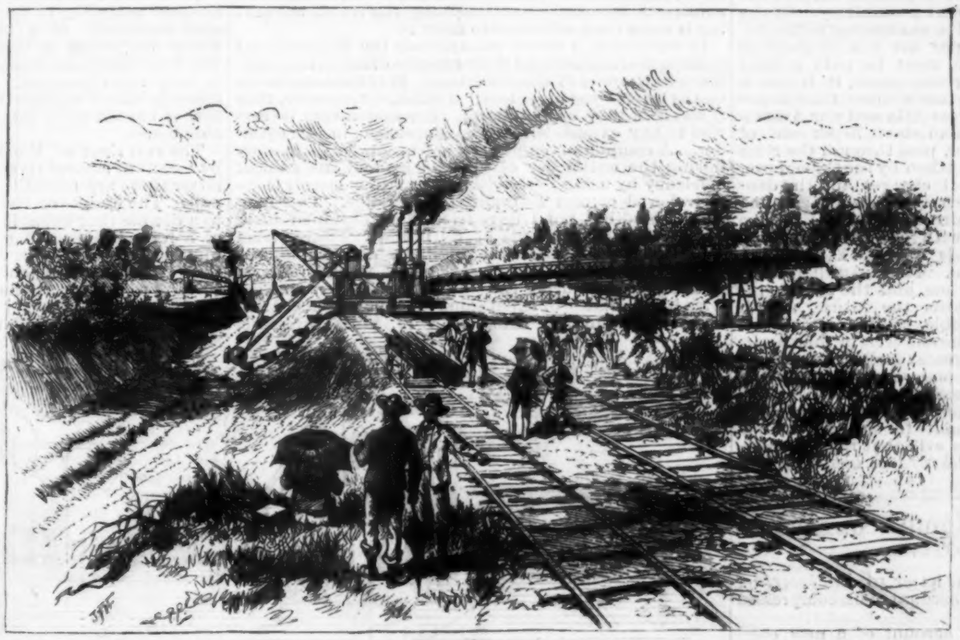
"The work on the isthmus, employing 12,000 men, is actively going on, with the machinery already fixed and in good order. The scenes are curious. The men are paid once a fortnight and on a Sunday. It is quite remarkable how cleverly the time keepers keep count of the many hundreds and thousands under them; and also, how very accurately the men themselves know how many hours they have worked in the fortnight. For it must not be imagined that these men work every day. When they think they have done enough, they remain away, and are lazy, smoking and drinking; and again, when they feel inclined, will return and work hard and well. Hence the difficulty of timing them. But when I saw them paid (which took six hours to do it at Tavernilla), there was only one trifling mistake. It was certainly very interesting to notice the different countenances and styles of hats and dress, as M. Musnier was paying them.

"As soon as the men are paid and have left the shed, they are pounced on by the women who have been supplying them with liquor, principally rum, on the tally system, and also with board and lodging. In most cases a warm argument goes on with regard to the number of drinks the woman has supplied the man with at his work. For these women carry baskets of spirits and a kind of native beer on to the works, and they are allowed to supply the men with what they choose; but if a man gets drunk, the women are sent away, and not allowed to return. Hence there are no cases of drunkenness during working hours, although it costs so little to get drunk on the vile rum that is supplied.

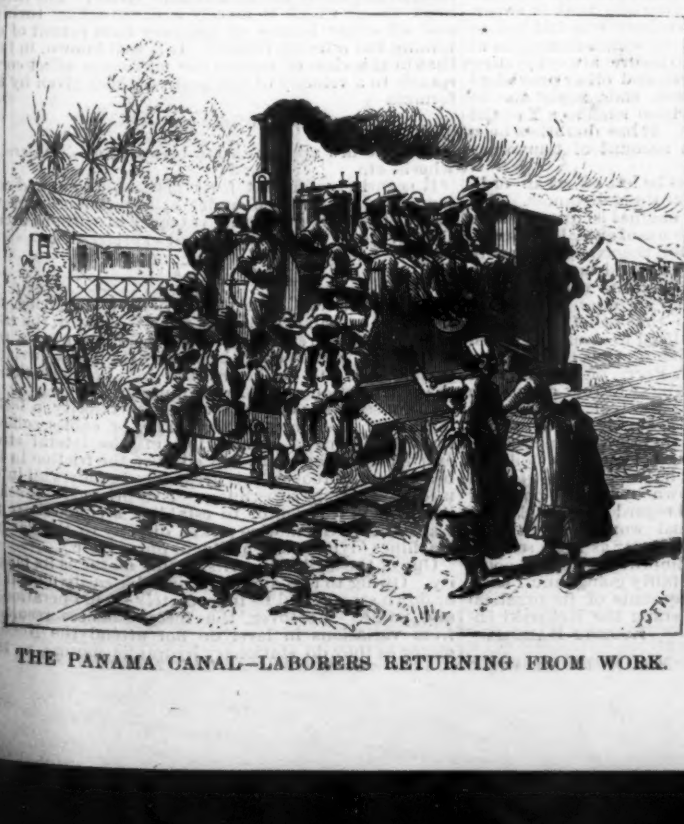
"After the day's work there is a general rush for the villages, and lucky are those who are in time to catch an engine, and thus save many miles of walking. When I saw them I was only surprised that the men and women did not try to get *into* the engine as well as *on* it; they crowded on every conceivable part, almost hiding the engine from sight.

"The employers and work people on the canal live in little towns, which abound in stores and rum shops and gambling tables. Most of the workmen on the Panama Canal are negroes from Jamaica; but there are men from all parts. The Barbadians are reputed the laziest and most impudent of all. There are also Kroo boys from the west coast of Africa, and these make good workmen."

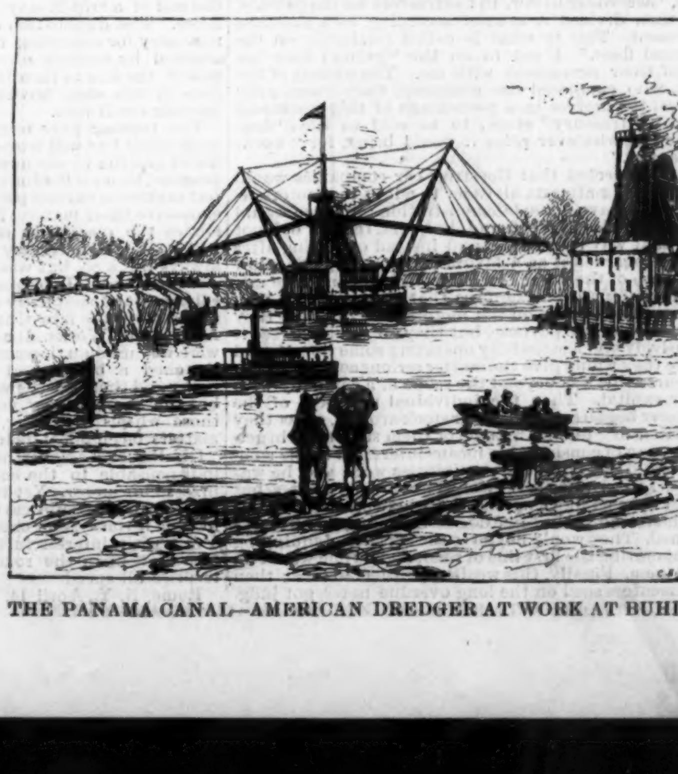
We have refrained from expressing any opinion with regard to the financial prospects of the undertaking, or the pecuniary means likely to be forthcoming to



THE PANAMA CANAL—EXCAVATING, WITH TRANSPORTERS OF EARTH, AT TABEMILLA.



THE PANAMA CANAL—LABORERS RETURNING FROM WORK.



THE PANAMA CANAL—AMERICAN DREDGER AT WORK AT BUHIO.

effect its completion. It might prove far from remunerative to the original shareholders, though profitable to the contractors; yet there can be no question that British mercantile and colonial interests, above all others, will derive great benefit from the opening of direct navigation, by the shortest possible route, between the two main oceans of the globe. If such a canal were available, it would be used for our commerce with the Pacific States of North America, which is now represented by over 700,000 tons a year, and by a value of nearly £9,000,000 sterling; it would be used for half of our trade with Mexico, which employs 180,000 tons of shipping annually, and a declared value of about £2,500,000; and it would absorb the whole of our trade with Chili and Peru, which gives employment to between 500,000 and 600,000 tons of shipping, and is officially valued as worth about £9,000,000 sterling per annum. But this, after all, is not its chief advantage to Great Britain. The many unsettled problems that still surround the question of the Suez Canal administration may at any time make it worth the while for England to possess yet another alternative route to her Australian colonies. But for the existence of the Suez Canal, the Panama Canal route would be much more convenient than any other to those countries, and the Suez Canal has not been administered in such a way as to give entire satisfaction to British shipping. The traffic is frequently so congested that vessels take as many days to pass through as they should take hours if the passage were perfectly free. The dues are very heavy, and in the recent depressed state of the freight market, have been almost prohibitory. Of the total cost of transport to India, amounting to 22s. 6d. per ton, no less than 9s. 6d. per net ton, or about 40 per cent. of the total freight, must be paid in Suez Canal dues. Under these circumstances, it is not a matter for surprise that not much more than 50 per cent. of our total imports from Asia and our Australian colonies, and not more than about 70 per cent. of our exports to those countries, pass through the Suez Canal. The remainder is still taken by the Cape route, avoiding the heavy Suez Canal charges, and the dangers and inconveniences of the frequent delays entailed by the congestion of traffic already referred to. The present value of our trade with our Australian colonies, imports and exports, is about £50,000,000 to £53,000,000 sterling per annum. The Australian trade is our most rapidly increasing one, and the most hopeful and encouraging as regards the future, and it should be afforded every possible facility for development. It is, of course, by no means certain that, apart from differences of distance, greater facilities would be likely to be afforded by the one route than by the other; but our shipping interests would be benefited by a choice of routes, no matter how controlled; as in most other cases of rival claimants for support, competition would effect a remedy for evils that remonstrance has hitherto failed to cure.—*Illustrated London News.*

HISTORY OF THE HARDIE COMPRESSED AIR LOCOMOTIVES.

MR. ROBERT HARDIE, in a letter to *Engineering*, gives the following interesting account of his compressed air experiences:

I read, with interest, your account of a new compressed air tramway car, on the Mekarski system, in a recent issue of your paper, having been engaged on similar experiments myself. A compressed air locomotive, designed by me, and constructed under my supervision, was tried on the New York Elevated Railway about six years ago, with the most favorable mechanical results. It performed as much work on one charge of air as the steam locomotive with one tank (600 gallons) of water, and otherwise answered all the requirements of the service. I also constructed several tramway cars which gave good results, running as much as ten miles without recharging. It was found, too, that the cost was less than for horse haulage, and altogether their adaptability for the work was fairly demonstrated. What became of them? A company had been formed with a large capital (which was unfortunately all on paper), but they were not the right kind of men to handle an enterprise of the kind, as events proved.

It may interest your readers to know how this paper company was floated and what became of it. I entered into an agreement with a syndicate to assign the patents to trustees, in consideration for which they came under certain obligations to me. They then put a value on the patents equal to the amount at which they wished to capitalize the company. When the company was chartered, they sold the stock at its "full par value," according to law, to the trustees for the patents, who then divided it around according to a previous agreement. This is what is called getting in on the "ground floor." I got in on the "ground floor" as part of their agreement with me. The owners of the stock, who composed the company, then voluntarily assessed themselves in a percentage of this stock and called it "treasury" stock, to be sold to the "dear public" at whatever price it would bring, for "working capital."

It was expected that the street car companies would come flocking after us, all eager to adopt the motors, as soon as we gave a good demonstration; and we would soon all be rich. We found, however, that it did not work that way in practice, and instead of coming after us they regarded it as a favor and a privilege to allow us the use of their tracks to show it to them. The majority wouldn't even grant us that favor. Those who came to see and ride on the motors thought that they might answer the purpose, but they all wanted to see it exclusively and successfully operating some line of road before they would give the matter serious consideration. Of course this was beyond the scope of a company with paper capital. Then the individual members of the company began to peddle their stock around, or, as they say, tried to "unload." Some of them succeeded in getting a man of considerable means interested in the company, who saw what the possibilities were, and he was induced to advance money on the company's notes, but he did not feel like carrying the whole company on his shoulders, and so the same dog-in-the-manger policy was pursued. They would not go to the expense of equipping and operating the first line of road, and no one would do it for them. Finally, this wealthy gentleman died; then his executors sued on the long overdue notes, got judgment, and wiped out the company. Now the scheme is generally regarded as having been tried and failed. I am satisfied, however, that compressed air is more suitable for tramway service than anything else which has been proposed, or tried, or boosted up with capital; and am glad to see that there is still a prospect of its coming to the front. Cable is very expensive, and has many practical disadvantages. No one, for instance, would think of constructing a steam or compressed air motor which could not run both backward and forward. Electricity, too, has many disadvantages. Storage batteries are unsuitable, if for no other reason than the time it takes to charge them. Naked conductors are objectionable, for even if there was no danger attaching to them, there is liable to be too much leakage in wet weather. The armatures are liable to get burned out, and the commutators or collectors are expensive articles of consumption, it being difficult to control "sparking," and they being exposed to dirt and dust. Compressed air possesses all the advantages of steam, without its disadvantages, but for which steam would be best of all. It may be said that compressed air is not so reliable as steam, because the supply is liable to give out during a trip. I answer that both are liable to give out during a trip that is undertaken beyond their respective capacities. It has been urged that compressed air motors of sufficient capacity to answer all the requirements of street car service are too heavy for the tracks. I reply that a roadbed which would suffer from the weight of such a motor would suffer from the ordinary street traffic over it, and even if additional expense is incurred in maintaining the track, the saving is more than sufficient to meet it.

In conclusion, I would remark that the Mekarski car as described seems to me to be capable of much improvement in the way of simplification. It is liable to strike one as being "too ingenious." I think, for instance, that it was a mistake to compound. Expansion may be carried to any extent, without condensation, in one cylinder. A compound engine cannot be operated as such during the entire use of one charge, and the gain of efficiency by using high initial pressures is merely theoretical, and cannot be realized in practice. This may seem incredible, but I have tried it. I obtained most beautiful indicator cards at all initial pressures from 400 lb. to 100 lb. notwithstanding which the motors would run as far on one charge of air, when I reduced to about 120 lb. during the entire trip, as when working with high grades of expansion. Beaumont also tried it by compounding, using 1,000 lb. initial pressure, with the same results. The Society of Arts *Journal* of March 18, 1881, contains a report of a paper read by him, in which he claimed and seems to have conveyed the impression that there was economy in it, and he was complimented for his ingenuity; but no one seemed to observe that the reservoir gauge pressures given by him at the end of every 1,000 yards run by his motor showed practically the same fall of pressure from first to last, or in other words, that the same quantity of air was used, whatever the initial pressure. Hence without loss of practical efficiency he might have reduced the pressure all through, and saved the machinery the excessive strains. It is also very doubtful if reheating between the cylinders will result in sufficient gain to justify the complication. It seems to me also that the complication involved in reserving one tank is superfluous, for the pressure in the others will fall just so much faster, and there should be sufficient margin at the end of a trip in any case to insure always getting there. The duplication of parts, and other provisions necessary for operating from both ends, might also be avoided by making some provision such as a Y at the end of the line to turn the car. It has doubtless been done in this case, however, on account of temporary existing conditions.

The turning gear might also be left off, as an ordinary pinch bar will move the car short distances. The use of gearing to connect the engines is questionable practice, though it admits of the use of a smaller engine, but making a curved pedestal for the axle box is more expensive than making it straight, and moreover precludes the possibility of coupling the wheels, which will be found necessary on heavy grades. I did not always think so, but was led to that belief by force of circumstances. I confess it is hard to decide between efficiency and simplicity sometimes. Once, in a conversation with the late Charles T. Parry, of the Baldwin Locomotive Works, I asked him why cut-off valves were not used on locomotives. He took a pencil and sketched a boiler and wheels, saying, "There is a boiler and there are the wheels, these are indispensable; but the shortest way you can get from that boiler to those wheels the better," and he was an old sage in matters mechanical, being known by the sobriquet of "Old Brains." Nevertheless, I regard cut-off valves as indispensable to the economical working of a compressed air motor. Yet this one, so far as I can see, has not got them. Doubtless many improvements will come in time if the system once gets fairly going, and I shall await with interest further accounts of its practical operation upon the road. Wishing the Mekarski enterprise all speed. ROBERT HARDIE.

Rome, N. Y., April 14, 1888.

A NEW FLUVIATILE MOTOR.

THE utilization of the immense motive power of large rivers and its application to the industries, agriculture, etc., in recent times, and also for lighting and the transmission of electric power, is a problem that has always occupied engineers, but is one that has not as yet been completely solved.

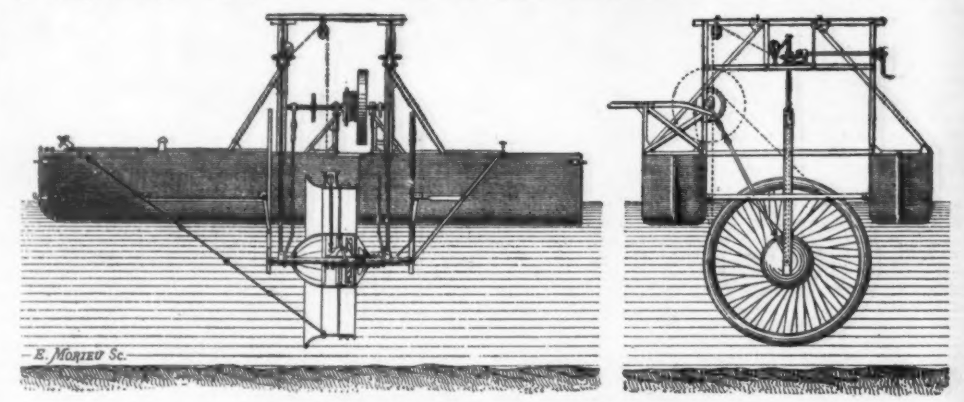
As the natural slope of most rivers is quite slight, it has been necessary either to have recourse to costly artificial constructions, as in the case of setting up turbines, or to give water wheels colossal dimensions in order to compensate for the want of head through the increase in volume of the active water.

From this standpoint, Mr. Nossian's hydraulic motor must be considered as a genuine and remarkable progress. While in steamboat wheels only the superficial layers of water exert their action in a transverse section equal to the feeble width of the paddles, and the lower masses of water have no effect on them, the wheel of the Nossian motor, which presents its entire circular area to the current, utilizes the motive power of the liquid throughout the entire height of the transverse profile of the bed. With relatively small dimensions, it is thus possible to obtain a much greater power.

In large watercourses, the Nossian motor is mounted between two wooden or iron pontoons, while in small streams and canals of sufficient depth it is mounted between two simple scaffolds.

The motor is so arranged that it can be raised and lowered according to the height of the water, and consists essentially of a helicoidal iron plate wheel in which the water is directed by a fixed distributor. The two wheels are mounted upon a shaft which runs in very tight bearings. Tightening chains keep the steering wheel against the pressure of the water, so that it cannot move laterally with respect to the movable wheel.

The two rings of the movable wheel are assembled by means of several riveted paddles, and between these latter there are movable paddles provided with journals. The cranks of the interior journals are jointed to a double ring capable of being displaced by means of a forked lever and a rod. The latter is displaced under the action of a very sensitive regulator, which thus varies the position of the movable paddles. According to the variations in the resistance to be overcome and the velocity of the water, the channels between the paddles of the wheel open more or less, and the changes in the area of the transverse section thus produced cause the motor to run with a uniform speed.



NOSSIAN'S FLUVIATILE MOTOR.

The motion of the movable wheel is transmitted, by means of a chain or cable winding around it, to an intermediate shaft which is connected with the driving shaft by means of two rods, and the pillow blocks of which are capable of sliding in lateral guides, so that it is possible to submerge the motor to any desired depth, and set it running at once without disengaging gear.

This new motor operates by reaction, and the consequence is that its angular velocity, or the number of revolutions of the wheel per unit of time, is greater than in any other known fluviatile motor. The Girard helix wheel, which is merely a direct-acting turbine, and all other helices of ordinary form permit of obtaining but a feeble velocity. It is well known, in fact, that in this class of motors the maximum effect corresponds to a velocity of the motive wheel given by the formula

$$0{\cdot}5\sqrt{2\,gh}$$

This same law applies also to breast wheels, undershot wheels, etc.

It is entirely different for reaction motors, and consequently for the one under consideration. The velocity of all motors of this category is, without exception, greater. The formula that expresses it is

$$0{\cdot}7\sqrt{2\,gh}$$

and, if we select the best conditions for utilizing the reaction, we can even increase the velocity in the ratio of 9 to 7. It is readily seen that we have here a fact of prime importance for the construction of a fluviatile turbine, and this has been taken into consideration in the construction of the Nossian motor.

In consequence of the great rotary velocity, a feeble tension of the transmitting chains or cables suffices, thus producing a diminution of the lateral stress exerted upon the shaft, as well as of the friction in the bearings. Moreover, this great speed renders all intermediate gearings superfluous. Exceptional cases aside, it suffices in this motor to establish a single shaft for transmitting the motive power directly to the various machines (dynamos, centrifugal pumps, etc.).

One of the striking merits of this motor is its mobility. Owing to this quality, it can be easily moved up or down stream and be immediately set in operation at any point. Moreover, the inconveniences resulting from variations in level do not attend the Nossian motor as they do stationary hydraulic motors, as this

apparatus adapts itself to every change of level at any given moment whatever. Finally, it may be remarked that in rivers where there is floating ice, the motor can be put in safety by a simple operation that requires very little time.

Among the numerous uses that can be made of this new fluviatile turbine in all streams whose depth is sufficient, may be mentioned, as the most important, electric lighting and transmission of power.—*La Lumière Electrique.*

[NATURE.]

TIMBER, AND SOME OF ITS DISEASES.*

By H. MARSHALL WARD.

VII.

IF we pass through a forest of oaks, beeches, pines, and other trees, it requires but a glance to see that various natural processes are at work to reduce the number of branches as the trees become older. Every tree bears more buds than develop into twigs and branches, for not only do some of the buds at a very early date divert the food supplies from others, and thus starve them off, but they are also exposed to the attacks of insects, squirrels, etc., and to dangers arising from inclement weather, and from being struck by falling trees and branches, etc., and many are thus destroyed. Such causes alone will account in part for the irregularity of a tree, especially of a conifer, in which the buds may be developed so regularly that if all came to maturity the tree would be symmetrical. But that this is not the whole of the case can be easily seen, and is of course well known to every gardener and forester.

If we remove a small branch of several years' growth from an oak, for instance, it will be noticed that on the twigs last formed there is a bud at the axil of every leaf; but on examining the parts developed two or three years previously, it is easy to convince ourselves of the existence of certain small scars, above the nearly obliterated leaf scars, and to see that if a small twig projected from each of these scars the symmetry of the branching might be completed. Now, it is certain that buds or twigs were formed at these places, and we know from careful observations that they have been naturally thrown off by a process analogous to the shedding of the leaves; in other words, the oak sheds some of its young branches naturally every year. And many other trees do the same; for instance, the black poplar, the Scotch pine, *Dammara*, etc.; in some trees, indeed, and notably in the so-called swamp cypress (*Taxodium distichum*) of North America, the habit is so pronounced that it sheds most of its young branches every year.

But apart from these less obvious causes for the suppression of branches, we notice in the forest that the majority of the trees have lost their lower branches at a much later date, and that in many cases the remains of the proximal parts of the dead branches are sticking out from the trunk like unsightly wooden horns. Some of these branches may have been broken off by the fall of neighboring trees or large limbs; others may have been broken by the weight of snow accumulating during the winter; others, again, may have been broken by hand, or by heavy wind; and yet others have died off, in the first place because the overbearing shade of the surrounding trees cut off the access of light to their leaves, and secondly because the flow of nutritive materials to them ceased, being diverted into more profitable channels by the flourishing, growing parts of the crown of leaves exposed to sunlight and air above.

The point I wish to insist upon here is that in these cases of branch-breaking, however brought about, open wounds are left exposed to all the vicissitudes of the forest atmosphere; if we compare the remnant of such a broken branch and the scar left after the natural shedding of a branch or leaf, the latter will be found covered with an impervious layer of cork, a tissue which keeps out damp, fungus spores, etc., effectually.

It is, in fact—as a matter of observation and experiment—these open wounds which expose the standing timber to so many dangers from the attacks of parasitic fungi; and it will be instructive to look a little more closely into the matter as bearing on the question of the removal of large branches from trees.

If a fairly large branch of a tree, such as the oak, is cut off close to the trunk, a surface of wood is exposed, surrounded by a thin ring of cambium and bark (as in Figs. 21 and 22). We have already seen what the functions of the cambium are, and it will be observed that the cut edge of the cambium (C) is suddenly placed under different conditions from the usual ones; the chief change, and the only one we need notice at present, is that the cambium in the neighborhood of the cut surface is released from the compressing influence of the cortex and bark, and owing to this release of pressure it begins to grow out at the edges into a cushion or "callus," as shown in Figs. 23 and 24. A very similar "callus" is formed in the operation of multiplying plants by "cuttings," so well known to all; the cambium at the cut surface of the "slip" or "cutting" is released from the pressure of the cortex and begins to grow out more rapidly in the directions of less pressure, and forms the callus.

FIG. 21.—Portion of a tree from which a branch has been cut off close to the stem. C, the cambium of the branch; B, the cortex.

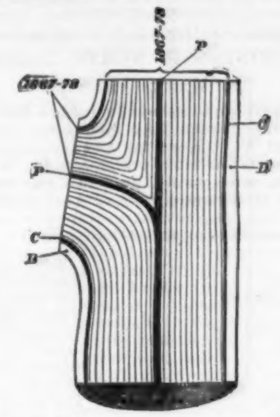


FIG. 22.—The same in longitudinal section. P, the pith of stem and branch; on either side of this are the twelve annual zones of wood produced during the years 1867-78, as marked. The cambium, C, separates these from the cortex, B.

Now this callus (Fig. 23, *Cal*) is in all cases something more than mere cambium—or rather, as the cambium extends by cell divisions from the cut edge of the wound, its outer parts develop into cortex, and its inner parts into wood, as in the normal case. The consequence is that we have in the callus, slowly creeping out from the margins of the wound, new layers of wood and cortex with cambium between them (Fig. 24); and it will be noticed that each year the layer of wood extends a little further over the surface of the wound, and toward the center of the cut branch; and in course of time, provided the wound is not too large, and the tree is full of vigor, the margins of the callus will meet near the middle, and what was the exposed cut surface of the branch will be buried beneath layers of wood and cortex, between which lies the cambium, now once more continuous over the whole trunk of the tree (Figs. 25 and 26).

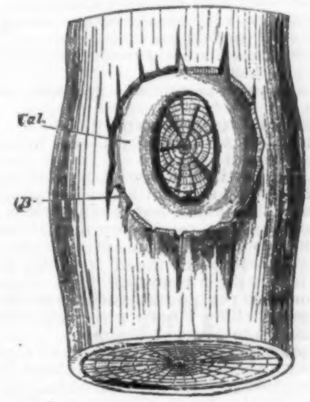


FIG. 23.—The same piece of stem four years later. The cushion-like development, *Cal*, resulting from the overgrowth of the cambium and cortical tissues of the cut branch, has extended some distance from the edges, and is covering in the exposed wood. B is the dead outer corky tissue, incapable of growth, and partially cracked under the pressures exerted by the thickening of the stem. The latter is somewhat swollen transversely, owing to the release of pressure in this region enabling the cambium to develop a little more actively here; the quicker growth of the occluding cushion in the horizontal direction is due to the same cause.

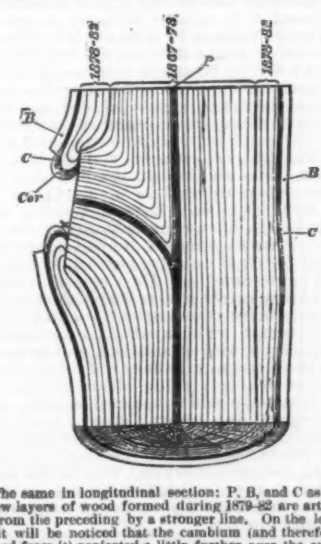


FIG. 24.—The same in longitudinal section: P, B, and C as before. The four new layers of wood formed during 1879-82 are artificially separated from the preceding by a stronger line. On the left side of the figure it will be noticed that the cambium (and therefore the wood developed from it) projected a little further over the cut end of the branch each year, carrying the cortical layers (*Cor*) with it. At ×, in both figures, there is necessarily a depression in which rain water, etc., is apt to lodge, and this is a particularly dangerous place, since fungus spores may here settle and develop.

It is not here to the purpose to enter into the very interesting histological questions connected with this callus formation, or with the mechanical relations of the various parts one to another. It is sufficient for our present object to point out that this process of covering up, or *occlusion*, as I propose to term it, requires some time for its completion. For the sake of illustration, I have numbered the various phases in the diagram, with the years during which the annual rings have been formed; and it will be seen at a glance that, in the case selected, it required seven years to cover up the surface of the cut branch (cf. Figs. 21-26). During these seven years more or less of the cut surface was exposed (Fig. 24) to all the exigencies of the forest, and it will easily be understood that abundant opportunities were thus afforded for the spores of fungi to fall on the naked wood, and for moisture to condense and penetrate into the interior; moreover, in the ledge formed at × in Figs. 23 and 24, by the lower part of the callus, as it slowly creeps up, there will always be water in wet weather; and a sodden condition of the wood at this part is insured. All this is, of course, peculiarly adapted for the germination of spores; and, since the water will soak out nutritive materials, nothing could be more favorable for the growth and development of the mycelium of a fungus. These circumstances, favorable as they are for the fungi, are usually rendered even more so in practice, because the sawyers often allow such a branch to fall, and tear and crush the cambium and cortex at the lower edge of the wound. These and other details must be passed over, however, and our attention be confined to the fact that here are ample chances for the spores of parasitic and other fungi to fall on a surface admirably suited for their development. The further fact must be insisted upon that numerous fungus spores do fall and develop upon these wounds, and that by the time the exposed surface is covered in (as in Fig. 25), the timber is frequently already rotten, usually for some distance down. In the event of fungi such as have been described above—parasites and wound parasites—gaining a hold on such wounds, the ravages of the mycelium will continue after the occlusion is complete, and I have seen scores of trees, apparently sound and whole, the interior of which is a mere mass of rottenness; when a heavy gale at length blows them down, such trees are found to be mere hollow shells, the ravages of the mycelium having extended from the point of entry into every part of the older timber.

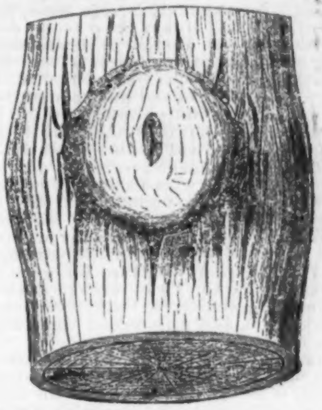


FIG. 25.—The same piece of stem six years later still; the surface of the cut branch has now been covered in for some time, and only a boss-like projection marks where the previous cut surface was. This projection is protected by cork layers, like ordinary outer cortex, the old outer cortex cracking more and more as the stem expands.

In a state of nature the processes above referred to do not go on so smoothly and easily as just des ribed, and it will be profitable to glance at such a case as the following.

A fairly strong branch dies off, from any cause whatever—*e. g.*, from being overshadowed by other trees. All its tissues dry up, and its cortex, etc., are rapidly destroyed by saprophytic fungi, and in a short time we find only a hard, dry, branched stick projecting from the tree. At the extreme base, where it joins the tree, the tissues do not at once perish, but for a length of from half an inch to an inch or so the base is still nourished by the trunk. After a time, the wind or a falling branch, or the weight of accumulated snow, etc., breaks off the dead branch, leaving the projecting basal portion; if the branch broke off quite close to the stem, the wound would, or at least might, soon be occluded, but, as it is, the projecting piece not only takes longer to close in, but it tends to rot very badly (Fig. 27), and at the best forms a bad "knot" or hole in the timber when sawn up. Of course, what has

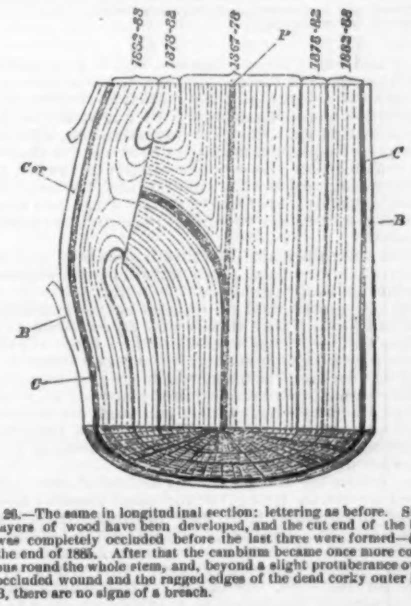


FIG. 26.—The same in longitudinal section: lettering as before. Six new layers of wood have been developed, and the cut end of the branch was completely occluded before the last three were formed—*i. e.*, at the end of 1885. After that the cambium became once more continuous round the whole stem, and, beyond a slight protuberance over the occluded wound and the ragged edges of the dead corky outer layers, B, there are no signs of a breach.

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* Continued from SUPPLEMENT, No. 648, page 10346.

already been stated of cut branches applies here; the wounds are always sources of danger so long as they are exposed.

It is beyond the scope of these articles to set forth the *pros* and *cons* as to the advisability of adopting any proposed treatment on a large scale; the simple question of cost will always have to be decided by those concerned. But whether it is practicable or not on a large scale, there is no question as to the desirability of adopting some such treatment as the following to preserve valuable trees and timber from the ravages of these wound parasites. Branches which break off should be cut close down to the stem, if possible in winter, and the clean cut made so that no tearing or crushing of the cambium and cortex occur; the surface should then be painted with a thorough coating of tar, and the wound left to be occluded. If the cutting is accomplished in spring or summer, trouble will be caused by the tar not sticking to the damp surface. Although this is not an absolute safeguard against the attacks of fungi—simply because the germinal tubes from spores can find their way through small cracks at the margin of the wound, etc.—still it reduces the danger to a minimum, and it is certain that valuable old trees have been preserved in this way.

Before passing to treat of the chief diseases known to start from such wounds as the above, it should be remarked that it is not inevitable that the exposed surface becomes attacked by fungi capable of entering the timber. It happens not unfrequently that a good closure is effected over the cut base of a small branch in a few years, and that the timber of the base is sound everywhere but at the surface; this happy result may sometimes be attained in pines and other conifers, for instance, by the exudation of resin or its infiltration into the wood; but in rarer cases it occurs even in nonresinous trees, and recent investigations go to show that the wood formed in these healing processes possesses the properties of true heart wood. At the same time there is always danger, as stated, and we will now proceed to give a brief account of the chief classes of diseases to which such wounds render the tree liable.

The first and most common action is the decay which sets in on the exposure of the wood surface to the alternate wetting and drying in contact with the atmosphere; it is known that wood oxidizes under such circumstances, and we may be sure that wounds are no exception to this rule. The surface of the wood gradually turns brown, and the structure of the timber is destroyed as the process extends.

The difficulty always arises in nature, however, that mould fungi and bacteria of various kinds soon co-operate in and hurry these processes, and it is impossible to say how much of the decay is due to merely physical and chemical actions, and how much to the fermentative action of these organisms. We ought not to shut our eyes to this rich field for investigation, although for the present purpose it suffices to recognize that the combined action of the wet, the oxygen of the air, and the fermenting action of the moulds and bacteria, etc., soon converts the outer parts of the wood into a mixture of acid substances resembling the humus of black leaf mould.

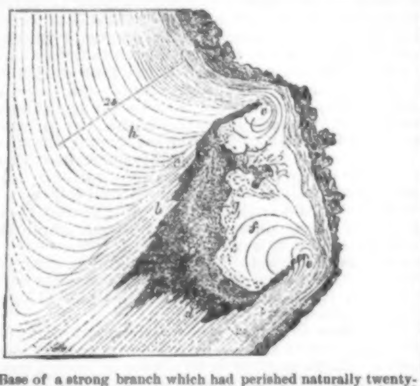


FIG. 27.—Base of a strong branch which had perished naturally twenty-four years previously to the stage figured. The branch decayed, and the base was gradually occluded by the thickening layers of the stem; the fall of the rotting branch did not occur till six years ago, however, as can be determined from the layers at *e* and *f*, which then began to turn inward over the stump. Meanwhile, the base had become hollow and full of rotten wood, *g*. It is interesting to note how slight the growth is on the lower side of the branch base, *i*, as compared with that at *h* above; the line numbered 24 refers to the annual zones in each case. As seen at *b* and *d*, the rotting of the wood passes backward, and may invade the previously healthy wood for some distance. (After Hartig.)

Now as the rain soaks into this, it dissolves and carries down into the wood below certain bodies which are poisonous in their action on the living parts of the timber, and a great deal of damage may be caused by this means alone. But this is not all; as soon as the decaying surface of the wound provides these mixtures of decomposed organic matter, it becomes a suitable soil for the development of fungi which are not parasitic—*i. e.*, which cannot live on and in the normal and living parts of the tree—but which can and do thrive on partially decomposed wood. The spores of such fungi are particularly abundant, and most of the holes found in trees are due to their action.

They follow up the poisonous action of the juices referred to above, living on the dead tissues; and it will be intelligible that the drainage from their action aids the poisonous action as it soaks into the trunk. It is quite a common event to see a short stump projecting from the trunk of a beech, for instance, the edges of the stump neatly rounded over by the action of a callus which was unable to close up in the middle, and to find that the hollow extends from the stump into the heart of the trunk for several feet or even yards. The hollow is lined by the decayed humus-like remains of the timber, caused by the action of such saprophytes as I have referred to. Similar phenomena occur in wounded or broken roots, and need not be described at length after what has been stated.

But in addition to such decay as this, it is found that if the spores of true wound parasites alight on the damp surface of the cut or broken branch, their mycelium can extend comparatively rapidly into the still healthy and living tissues, bringing about the destructive influences described in Articles III. and IV., and then it matters not whether the wound closes over quickly or slowly—the tree is doomed.

(*To be continued.*)

[Continued from SUPPLEMENT, No. 655, page 10463.]

MICA MINING IN NORTH CAROLINA.

By WM. B. PHILLIPS.

THE minerals found in mica veins are both numerous and interesting. Some time before his death, in 1885, the lamented W. C. Kerr, for twenty years State geologist of North Carolina, prepared a list of the minerals found in mica veins, and this has been corrected by F. A. Genth, and one or two added by W. E. Hidden.

The list is as follows, according to Kerr:

Albite,	Limonite,
Allanite,	Magnetite,
Amazon stone,	Menaccanite,
Apatite,	Muscovite,
Arethunite,	Phosphuranylite,
Autunite,	Rogersite,
Beryl,	Samarskite,
Biotite,	Thulite,
Columbite,	Torbernite,
Euxenite,	Tourmaline,
Glassy feldspar,	Uraninite,
Garnet,	Uranocher,
Gummite,	Uranotil,
Hatchettolite,	Yttrogummite.

F. A. Genth* corrects this list, and his criticisms are as follows:

"Amazon stone, perhaps, doubtful.

"Autunite (torbernite ?), *all* autunite.

"Biotite, probably, but I have not seen it from mica veins, as far as I remember.

"Euxenite does not contain TiO_2, and hence is not true euxenite.

"Glassy feldspar (sanidin), very doubtful.

"Pyrochlore, in very minute octahedra at the Ray mine, with black tourmaline.

"Yttrogummite—I do not know of any analysis having been made; very doubtful.

"Fluorite, in pseudomorphous granular patches after apatite.

"Apatite, seems to be fluorapatite.

"Orthoclase, often completely altered to kaolinite.

"Quartz, of course."

Neither Dr. Genth nor myself is able to identify Kerr's arethunite; it is most likely a *lapsus pennæ*. To this list Hidden has added fergusonite, which now sells for $5 a pound, manazite and æschynite (?) Large masses of samarskite are found in some of the mines, a piece weighing 94 pounds being taken from the Mart Wiseman mine, in Mitchell County.† This formerly sold, I believe, for $1.50 per pound, but is now offered at 75 cents per pound. The largest pieces ever found have been obtained from Mitchell County.

A rather curious bit of history and of etymology is associated with the feldspar altered to kaolinite. W. C. Kerr, in the paper previously referred to, says that the Indian name for the Smoky Mountains, *Unaka* Mountains, is derived from the Indian word for *white*, unakeh, and that they applied this name to them because they were accustomed to obtain white kaolin there, and to "pack" it to the coast for exportation 150 years ago. He does not give his authority for this statement, and I have not been able to find it. He may have ascertained it himself, but if so, he makes no mention of it.

The farmers near the mines are accustomed to apply the disintegrated feldspar to their crops, and it has given good results, containing as it does from 10 to 15 per cent. potash. Some attempts have been made to utilize the feldspar as a source of potash, but the experiments have not been successful on a commercial scale. With kainit of 13 per cent. potash selling at $11 per ton, it is doubtful whether the potash can be economically extracted from feldspar. I am informed that interest in the problem has somewhat revived of late. The material can be had in any quantities at an almost nominal cost, as it is obtained in great abundance, and constitutes at least one-third of the dumps.

From the list of minerals found in mica veins it will be seen that many of them are rare, and some quite so. Whatever agencies were at work during the formation of these veins, they seem to have conditioned the occurrence of some of the rarer minerals in considerable quantities. It is not without interest that fluorine was present at the time, occurring as it does in fluorite and fluorapatites. The well known decomposing power of this element, when present as hydrofluoric acid, or combined with lime, may have a bearing upon the constitution of the mica vein itself and of the minerals found in it. I have examined numerous specimens of apatite from Mitchell County, and so far have not observed any chlorapatite. Dr. Genth's experience, stretching over a much longer time than my own, and based on many more examinations, would seem to be in the same direction. The apatite is generally of the greenish variety, is well crystallized, and is usually embedded in the feldspar. It does not occur in sufficient quantity to be of much value, although the fine crystals can of course be sold to mineral dealers, and occasionally an extra fine crystal may be used as a gem stone. Some large and a few really handsome beryls have been found, notably at the Ray mine, in Yancy County. An hexagonal crystal, now in the possession of the writer, but unfortunately broken, is 8½ inches long, and was originally 3¼ inches in diameter. It is, however, quite opaque.

At the Grassy Creek mine, Mitchell County, crystals 2 feet long and 7 inches in diameter have been found.‡

The recent discovery of germanium in euxenite§ lends some interest to the reported discovery of this mineral in mica veins. Dr. Genth, however, says that the mineral reported as euxenite does not contain TiO_2, and is hence not a true euxenite, and as germanium, besides occurring in argyrodite, is supposed to accompany titanium, it is hardly likely to be present in this so-called euxenite. Allanite is found in slender, black crystals, 6 to 12 inches long, at the Balsam Gap mine, Buncombe County, and at the Clarissa (Buchanan) mine, Mitchell County.

Albite occurs at the Presley mine, Haywood County, as an alteration product of the decomposition of corundum. Columbite occurs embedded in samarskite at the Wiseman mine, Mitchell County, and rogersite at the same mine "in white mammillary crusts and little pearly beads upon samarskite."

Monazite occurs in feldspar, at the Ray mine, autunite and phosphuranylite on quartz and feldspar at the Flat Rock and Clarissa mines, Mitchell County.

A piece of gummite weighing 6 pounds 6 ounces, but partly altered to uraninite, has been found in Mitchell County, according to W. E. Hidden.

It is proposed in this article to describe the process of dressing the rough mica, or, as it is termed, "block" mica.

The rough mica is hoisted from the mine in blocks of considerable size, weighing from 50 to 250 pounds, tabular in shape, and more or less contaminated with fragments of feldspar, quartz, waste mica, etc. It is the purpose of the dressing to free the blocks from all materials not made use of in preparing cut mica. This is all done by hand, and consists in cleaving a block with thin steel wedges along the planes of lamination, separating it into a number of tabular pieces about ½ inch thick, and as large as the stock will allow. These pieces are then further cleaved until the proper thickness for cut mica is attained, this being, according to the use it is to be put to, from ⅛ to $\frac{1}{16}$ inch, or even thinner. The workman doing this also frees the sheets from adhering quartz, fragments of mica, etc., and passes them to the "scriber."

Scribing is an operation demanding a considerable degree of skill and experience. Upon it depends the yield of cut from block mica. It is performed by laying upon the sheet the pattern by which it is to be cut, and marking or scribing around it with a knife or similar instrument. The patterns are pieces of tin, sheet iron, etc., with the shape and size determined by the order from the mica brokers or dealers in the large cities, or by the stove maker himself. In Mitchell County alone there are about 100 different patterns, and their shape and size is constantly varying according to the fashion for stove windows. The size of cut mica was formerly of much greater consequence than at present. Several years ago there was a regular and systematic increase in value with the increase in size, the quality of course remaining the same. This is true to some extent now, though there appears to be a decided tendency toward smaller patterns. The first noticeable change in this respect was perhaps in 1883-84, when the stove manufacturers were compelled by the scarcity of large mica to use smaller sheets. They found the change so advantageous to their pockets that they persevered in it, and thus influenced the mica trade no little.

I would not be understood as saying that small mica is as valuable as large mica, but that large sheets are not as valuable as they were ten years ago. There is a limit below which it is not safe to go, and I should be inclined to put it at 3×6 inches. The patterns range in size from 1×1 inch up to 8×10, or as large as the stock will permit, increasing one-fourth inch each time. As the value of the mica increases at the same time, it becomes necessary to cut from a given rough sheet the largest number of patterns of the highest market value. The price of mica depends not only upon the size, but also upon its freedom from specks, stains, cloudiness, and striations, these conditioning its quality. Of late, too, a certain amber or rum colored mica has become fashionable, and fancy prices are sometimes paid for a good lot of extra "rum" mica. The regular colorless or "white" mica, however, commands the bulk of the trade. Certain mines, as for instance the Clarissa, are famous for "rum" mica.

As, after the scribing, the sheets are cut with heavy shears along the lines marked down, it will at once appear that much skill and experience are required of a good scriber. He must be constantly on the alert to furnish from every piece the largest number of valuable cut sheets. With the diversity in patterns and prices, and the variation in the mica itself, this becomes no easy task. A good scriber always commands good wages, for upon his skill depends the yield of cut from block mica. No matter how much block mica is brought to bank, nor how good the quality of it, if the sheets be not properly scribed the yield of cut mica diminishes, and with it the profit. A really skillful scriber will get from a given block twice as much cut mica as a beginner. He sees at a glance just what patterns a certain sheet should yield, he instantly detects flaws, stains, etc., and with a few rapid movements of his marking implement he "scribes" the sheet and passes it to the "cutter," who merely cuts the sheet through along the lines marked. The different sizes are then cleaned of the fine filaments of mica with a stiff brush, wrapped in strong paper, generally in one pound packages, boxed and shipped. As most of the mines lie from 20 to 30 miles from rail, the haulage across country is costly. A railroad now being surveyed down the Toe River, between Mitchell and Yancey counties, will give an outlet north via the East Tennessee, Virginia & Georgia Railroad, and south via the Richmond & Danville (Western North Carolina division), or the Charleston, Cincinnati & Chicago Railroad, now building. I approach the subject of the yield of cut mica from block mica with some hesitation. Cut mica is the only product of a mica mine that is sold on a commercial scale. It determines the value of the mine. So much depends on the quality of the blocks and of the rough sheets, whether they are stained, or cloudy, or flawy, or striated, so much depends on the skill of the scriber, and other local conditions, that what is here said is to be taken as applicable to average conditions.

On the average, therefore, 100 pounds of block mica should yield from 10 pounds to 12 pounds of cut mica. Instances are not unknown where the yield has fallen to 5 per cent.; it has risen at some mines to 33 per cent., and once to 75 per cent. This last yield is very far above the average, and has been obtained only once, so far as I know. With the general average of block mica a 12 per cent. yield in cut mica is considered a fair return. These 12 pounds will vary in value according to the quality and size of the patterns, the highest price being $4 per pound, the average price being not far from $1.75.

A 12 per cent. yield with these figures will give an average value of $21 per 100 pounds of block mica, or $420 per

* Priv. com., October 3, 1887.

† D. A. Bowman, priv. com., November 5, 1887.

‡ See abstract of Gerhard Kruss' paper before Munich Chem. Soc., Dec. 16, 1887, in *Engineering and Mining Journal*, vol. xlv., No. 7, p. 125.

§ Minerals and Mineral Localities of North Carolina. 1881, F. A. Genth and W. C. Kerr.

ton of 2,000 pounds. That the business has been profitable may be realized by remembering, as stated in No. 1 of these articles, that in 1880 there was invested in North Carolina mica mines $6,900, and the value of her product was $61,675. As was remarked then, I cannot say whether these figures are correct or not. One may be allowed one's own opinion, and some would say it is too good to be true. It has been stated * that in the Carolinas the mica is more apt to have a twisted structure, and to be stained or cloudy, than the New Hampshire mica. This could be known only by comparing the percentage yield of cut from block mica, as twisted or A mica and strained mica is not included in cut mica.

Prof. Shaler speaks also of the relatively small amount of gangue in the richer parts of the vein compensating for the increased expense of mining Carolina mica. This has less to do with the yield of cut mica than the quality of the blocks. The greater or less preponderance of gangue may, and doubtless does, influence the mining account, and so, indirectly, the balance sheet; but the value of 100 pounds of block mica depends less upon the percentage of gangue than upon the quality of the cut mica obtained from it. The assertion that Carolina rough mica yields less cut mica than that from New Hampshire remains to be proved.

In bringing these articles to a close it seems necessary to explain why no statistics have been given. Such as are accessible will be found in a compilation by the writer, to be published shortly in the "Mineral Resources of the United States for 1887," U. S. Geological Survey. In this volume will be found also a more concise and less technical account of the industry, and those who wish a bird's-eye view of the matter are referred to it.

North Carolina, for several years past, has contributed over 60 per cent. of the mica produced in the United States. With New Hampshire, she produces fully 95 per cent. of the better quality of mica in the country, and while, indeed, it cannot be asserted that her mica is better than that from other sources, it is just as good, and the statistics above referred to show that it is mined at less cost than New Hampshire mica.

I must say, however, that in my opinion these statistics are erroneous. There cannot exist such a difference between the effective value of a dollar in North Carolina and New Hampshire as they reveal. It is impossible to believe that one dollar in North Carolina yielded $8.93, and in New Hampshire only 20 cents, especially when we consider that, in the former State, shaft mining is the rule and open cut the exception, and in the latter, open cut is the rule and shaft mining the exception.

The much vexed question of cost accounts should not be submitted to census takers. It needs something more than mere scientific information to settle the actual cost of even so simple a product as mica, and while the local conditions in North Carolina favor cheap mining, they do not necessarily imply it. After devoting several years to the study of North Carolina mica mines, and, what is a still more difficult subject, mica *miners*, I do not as yet find myself in a position to give an opinion on the cost of a pound of mica ready for shipment. That it is less now than it was ten years ago there is good reason for believing, as also for believing that it will be still further diminished by the introduction of improved machinery, drills, hoists, etc.

The miners and dealers in North Carolina are not at present at all happy over their prospects. The change to a smaller pattern, the importation of foreign mica (which pays no duty), and the discovery of other mines, as in Dakota, Black Hills, Colorado, etc., are among the chief causes of alarm.

The output is diminishing, and that in spite of many good mines still unworked. The industry, while indeed never of any very great dimensions, was of considerable consequence to the immediate vicinity.

Probably $300,000 was the greatest value ever reached by any annual yield, and for the 20 years in which the business has been carried on it is not likely that the value of the product exceeds $1,700,000.

Mitchell and Yancy counties have contributed most of the mica from North Carolina. Good mines have also been opened and worked in the counties of Stokes, Cleveland, and Rutherford, east of the Blue Ridge, and Buncombe, Haywood, Jackson, Macon, and Cherokee west of the ridge.

According to W. C. Kerr, † a timbered shaft, 100 feet deep, has been discovered on Valley River, Cherokee County.

F. W. Simonds states ‡ that in the Guyer mine, Macon County, at depths varying from 35 to 50 feet in a shaft of prehistoric age, were found in 1875 some iron implements, as a pair of gudgeons, a wedge, etc., of wrought iron. Shaft mining has been carried on in this State for 200 years or more. An exploring party sent out by De Soto may have penetrated as far north as the southwestern corner of North Carolina.§

Prehistoric remains of open cuts and shafts for mica mining are found in Alabama, along a line stretching from Chilton County northeast through the counties of Coosa, Clay, and Cleburne. ‖

It is a little surprising that an industry so old, and yet so new, should have received such scant attention. There is, perhaps, in the whole country no better place for the study of fissures, and of the forces causing them, than a well opened mica mine.

It is the purpose of the writer during the ensuing summer to figure and describe more particularly some of the more interesting of these mines in Yancy and Mitchell counties, and to seek anew for the relations subsisting between the quality and quantity of the mica, and the depth, dip, strike, and walling of the vein, and the influence exerted by accompanying minerals.

If what has been said shall lead those concerned in such matters to inquire more especially into them, these articles have not been written in vain. The mica mining counties will well repay close study, not only on account of the mica, but even more on account of other minerals, as iron ores, chrome ores, corundum, asbestos, graphite, talc, etc. Some of the most magnificent forests of virgin timber in this or any other country still adorn the mountains and hills of these counties. Chestnut, locust, walnut, poplar, pine, cherry, etc., flourish in great abundance and beauty. The new railroad projected down the Toe River into Tennessee will open a country that needs only to be known to be appreciated. A fertile soil, an unsurpassed climate, varied and abundant natural products, all combine to render this part of North Carolina the potential garden spot of the State.—*Engineering and Mining Journal.*

* N. S. Shaler, 10th U. S. Census, vol. xv., p. 834.

† Rept. of Prog. N. C. Geol. Survey, 1869, p. 56.

‡ Amer. Naturalist, Jan., 1881. Reprint.

§ Bancroft, Hist. of the U. S., 13th ed., vol. i., pp. 47,48.

‖ Eugene A. Smith, State Geol. Ala., priv. com., Oct. 4, 1887.

NOTES ON THE ROCK SALT MINES OF PETITE ANSE, LOUISIANA.*

By H. CARRINGTON BOLTON, Ph.D.

THE southern coast of Louisiana, west of the Mississippi River, is indented by several bays through which the waters of innumerable bayous pass into the Gulf of Mexico. Near the head of one of these bays, known as Vermilion Bay, there is a nearly circular island of about 2,500 acres in extent, which rises above the low marshes of the vicinity to the height of 180 feet, forming a notable feature in the monotonous landscape. This is the well known island of Petite Anse, also called Avery's Island, after its present owners, in which occurs a remarkable deposit of rock salt. Petite Anse is now easily reached by rail via the Southern Pacific Railroad, from New Orleans as far as New Iberia (about 125 miles), and thence, by a branch road, 10 miles long, to the salt mine. Cotton and sugar plantations, uncultivated fields, marshes, corn fields, and cypress swamps alternate with luxurious forests of live oak, gum, hickory, black walnut, cypress, maple, and magnolia. About two-thirds of the island are under cultivation, the most profitable crops being sugar, salt, and Tabasco pepper sauce. Three ranges of hills can be traced, the surface water from which has cut its way deeply through the alluvial deposits, forming ravines, which, with ponds, forests, and cultivated fields, make the island a picturesque oasis in a wilderness of marsh and cypress swamps.

The existence of salt on this island has been known for a very long time, as shown by the fragments of pottery, arrow heads, and basket work found mixed with bones of the mastodon, buffalo, and deer, unearthed in recent excavations. The written history of the deposit begins with 1791, when John Hays found a brine spring while hunting. In the last century salt was made by boiling down the brine, and between the years 1812 and 1815 the amount produced was large. It then ceased for a time. Later, Judge D. D. Avery became owner of the island, and at the outbreak of the rebellion renewed operations on a large scale; the blockade made salt exceedingly valuable, so that one time a bag of salt was exchanged for a bale of cotton. On May 4, 1862, Mr. John Marsh Avery attempted to deepen a brine pit, and struck rock salt at a depth of 16 to 17 feet below the surface. The Confederate government then instituted mining by means of pits, and 400 to 600 men being constantly employed, the island was a scene of prodigious activity. The Northern troops, however, seized the island April 20, 1863, and put a stop to the industry. During these eleven months, about twenty-two million pounds of salt are estimated to have been taken out, the average price being 4½ cents per pound.

The first scientific observer who visited the deposit after these events was Professor Richard Owen, in November, 1865 (*Am. Jour. Science*, July, 1866, p. 120). In 1866, Professor Charles A. Goessmann visited the place on behalf of the American Bureau of Mines ("Report of the American Bureau of Mines on the Rock Salt Deposit of Petite Anse," 4to, New York, 1867), and one year later it was examined by Professor E. W. Hilgard, of the Geological Survey (*Am. Jour. Science*, January, 1869, and "Mineral Resources of the United States," Albert Williams, Jr., Washington, 1883).

To the reports of these gentlemen we owe some of the particulars of this notice.

The rock salt lies only fifteen to twenty feet beneath the surface. The surface soil is a dark loam, beneath which occur layers of coarse and fine sand, gravel and clay, all irregularly stratified and in no definite direction. The salt itself occurs as a massive crystalline rock of a saccharoidal texture, dry, hard, and homogeneous. It is of a white color, except in streaks or banks two to six inches in width, which are quite black. The salt appears to have a uniform character in all parts of the mine, and is remarkable for its purity, especially in its freedom from calcium and magnesium salts. It is quite free from potassium salts; for traces of Stassfurt salts I made especial search in vain. The following analyses show the great purity of this product:

	Analysis by Mr. F. W. Taylor (Smithsonian Institution), March, 1882.	Analysis by E. W. Hilgard, 1863.
Sodium chloride	98·731	99·880
Calcium sulphate	1·192	0·126
Calcium chloride	trace	trace
Magnesium chloride	0·013	100·006
Silica	0·024	
Iron sesquioxide	0·010	
Water	0·030	
	100·000	

Other analyses made by Professor Goessmann range from 98·88 to 99·60. It is of interest to compare this with rock salt from other localities:

	Cheshire.	Stassfurt.	Berchtesgaden.
Sodium chloride	98·30	94·57	99·85
Potassium chloride	—	—	trace
Calcium chloride	—	—	trace
Magnesium chloride	0·05	0·97	0·15
Calcium sulphate	1·65	0·89	—
Insoluble	—	3·35	—
Water	—	0·22	—
	100·00	100·00	100·00

Partial analyses of the black salt have been made by Mr. McCalla, the resident engineer and chemist, who finds that it yields a white solution and about seven per cent. of a white insoluble residue, chiefly gypsum. The black color, therefore, seems to be an optical phenomenon. These black bands form well marked folds in the salt, the space between the ridges and above them being filled with coarser granules of salt than the rest. Near these black bands the finest cleavage crystals of transparent purity are found. These bands seem to indicate that at some time the rock mass has been subjected to lateral pressure, causing ridges.

The geological features of the island and the origin of the salt deposit have been discussed by both Professor Goessmann and Professor Hilgard. The former thinks it is "probably of tertiary age," and says: "Many circumstances favor the theory that the deposit is a secondary one—resulting from the evaporation of brine springs, originating from beds of rock salt in some older geological formation—and not a direct residuum of the sea. This explains the entire absence of intercalations of gypsum and the absence of potassium and magnesium compounds."

Professor Hilgard thinks it should be assigned to the cretaceous, since there is "no phase of the tertiary history of the Gulf of Mexico that seems to admit of" the conditions required, viz., the long-continued evaporation of some very large body of sea water. He calls attention to the banded structure of the rock salt, and remarks that the "Stassfurt salts" belonging to the salt mass have long ago been washed into the general ocean.

We would call the attention of geologists to two facts which may throw light on the questions: the occurrence on the island of bedded sandstone and of lignite. The sandstone is exposed at the bottom of a deep ravine about 1,500 feet from the shaft; the rock is of a light gray color and contains little or no calcite. It is distinctly seen to be in place, and is weathered to a considerable depth beneath the surface. At the base of another ravine, formed by a rivulet cutting through the alluvium, gravel, and sand, and at a distance of about 2,000 feet from the shaft, there is an outcrop of lignite. The latter is apparently several feet in width and of good quality for economic purposes. Mr. McCalla reports that it contains fifteen per cent. of ash. Both the sandstone and the lignite seem to dip in such a direction (S.E.) as would cause them to run beneath the salt. This view is also confirmed by some of the borings. Indications of fossil plants occur in the brown coal, but at the time of my visit it was unfortunately impracticable to dig deeply into it, and I had to be content with a mere surface specimen.

There are four other islands stretching along the coast in the vicinity, but borings have failed to reveal salt on any of them.

The mine is now worked by a system of chambers and cross headings. The single shaft has reached a depth of 166 feet (including the sump of 6 feet). The old workings at a depth of 90 feet have been abandoned, owing to the infiltration from above of water carrying with it clay and sand, which rendered the salt impure. The lower level is at a depth of 160 feet. The extent of the excavation in the upper level is about 8 acres, and the extreme ends of the galleries are 900 feet apart. The excavation on the lower level is much smaller. The method of operating is to run galleries about 6 to 8 feet high, and then to work upward to a height of 40 feet, leaving between the galleries large pillars to support the roof. The boring is done with a kind of auger of a German pattern, imported in deference to the prejudices of the workmen, who are largely Stassfurt miners. The auger is worked by hand and penetrates the salt one inch for every twelve revolutions of the bit. The blasting is done with dynamite, of which 80 to 100 boxes, each containing 100 lb., are used every month, say on an average 150 lb. daily.

After blasting down 40 feet the salt is broken by sledges, placed in small hand carts, and hoisted on a platform to the surface by steam power. About one hundred men are employed by the company, of whom fifty work below the surface. They work on ten hours time.

The rock mass is quite dry, but, owing to bad management in the early history of the mine, water from the surface runs into it through seams and openings; to remove this two pumps, capable of throwing out 100 gallons per minute, are run about ten hours out of the twenty-four. The brine pumped out is allowed to waste.

Ventilation is necessitated by the great quantity of dynamite exploded daily. Air is supplied by a fan 8 feet in diameter, 4 feet wide, driven at about 250 revolutions per minute. This, it is estimated, supplies about 600,000 cubic feet of air per hour.

Pockets of an inflammable gas have been repeatedly struck, and on a recent occasion the issuing gas was lit and burnt for an hour or more. Perhaps this phenomenon is connected with the underlying lignite.

The engines used for running the blower, the fan, reels, breakers, etc., are three in number, and aggregate 250 horse power.

The salt brought to the surface is crushed between corrugated rollers driven at high speed; one set breaks it into lumps from two to three inches in diameter and finer. It is then ground into various grades by six buhr stone mills, each capable of grinding 50 tons in ten hours. The salt is sorted by jigs, revolving reels, and blowers, the fine dust being blown out by a horizontal current of air striking against a column of falling salt.

The salt is sent into market in eight grades: (1) Rock salt in lumps from 100 to 300 pounds, used by farmers, it being placed under sheds for cattle to lick. (2) Crushed salt that passes over ½ inch screens and through ¾ inch screens. (3) "Fish salt," including all which passes through a ½ inch screen. (4) Coarse ground. (5) Medium ground. (6) Fine ground. (7) For sack and barrel salt the coarser particles of grade 6 are screened out with a wire screen of ten meshes to the inch, and the fine dust is blown out. (8) The fine dust thus blown out divides itself by gravity into an impalpable part (which is thrown away, being a small percentage) and a coarser part, which forms table salt. The salt is shipped to market in sacks and barrels.

For the year ending July, 1887, the product was 44,000 tons. In a busy season the daily shipments run as high as 300 tons. Formerly the material was transported by water, through a canal expressly maintained for the purpose, into the bay, some miles distant; now the railway carries it exclusively.

The amount of salt in sight is very great, and the possible extent of the deposit is enormous. Borings show that about 142 acres of ground are underlaid with

* Abstract read before the New York Academy of Sciences, Feb. 13, 1888. From *Transactions of the New York Academy of Sciences*, vol. vii.

salt, the extreme depth of which has not been ascertained, though borings have been sunk 190 feet. Everywhere the character of the salt is the same, and the mine is evidently destined to supply the market for generations to come. At present the owners of the property have leased the mining privilege for a consideration to the American Salt Company.

[Specimens of sandstone, lignite, and salt were exhibited, the latter in transparent cleavage crystals, some of which measured 4×3×2 inches.]

Dr. Bolton expressed his obligations to Capt. Hascall for hospitality, and to the Messrs. Avery for courtesies during his visit. He also desired to thank Mr. McCalla for kind attentions and valued information.

SIR JOHN PENDER, K.C.M.G.

THE honor of knighthood has been recently conferred upon the subject of this memoir, and a banquet was recently given to celebrate the occasion at the Hotel Metropole, London. Sir John Pender, as everybody knows, is the Chairman of the Eastern, Eastern Extension, Direct United States, and Globe Telegraph Companies, and is the ruling influence in the councils of several other submarine cable companies. But it is, perhaps, not so widely known that in the early days of oceanic telegraphy, when the great experiment in the Atlantic had been tried and had failed, and when the promises held out by electrical science had been almost abandoned in despair, it was Sir John Pender who pushed the enterprise to a successful issue with the help of his money, his commercial credit, and the whole weight of his personal energy. At a critical moment in the history of the first Atlantic cables the project might have been delayed indefinitely but for the confidence inspired by Mr. Pender's heroic offers of assistance. A quarter of a million of money was needed to complete a new cable and make a fresh trial; and for this amount he gave his personal guarantee. The fact seems to have been that Sir John, as has ever since been his custom, took pains to satisfy himself as to the scientific and mechanical problems of the undertaking; and having consulted the highest authorities on these points, attacked the financial difficulties himself with perfect confidence in the result. Sir John is a warm patron of science, and to his enlightenment and liberality in this particular are largely due the improvements which continually are made in both the manufacture and the working of submarine cables.

A few particulars of Sir John Pender's life and career may be of interest here. He is a native of Scotland, his birthplace being the Vale of Leven, Dumbartonshire. As he was born in 1816, he is now in his seventy-second year, although, as will be seen by the portrait, which is from a photograph taken only in the present year, he looks at least eight or ten years younger, and has still the vigor and faculties of a man not nearly his age. Coming to England soon after leaving the High School at Glasgow, where he finished his education, he entered the counting house of a factory in Manchester, and after a few years' time rose to the management of the establishment. His success in business on his own account later on proved remarkable, resulting in the acquisition of a considerable fortune in the export trade of that manufacturing city, previous to his coming to the metropolis. His first connection with the telegraph appears to have been in the capacity of chairman to the British and Irish Magnetic Company; and from that period until now his chief energies have been devoted to the promotion of telegraphic enterprise. Sir John represented Totnes in Parliament from 1862 to 1866, and subsequently sat for the Wick Burghs through three successive Parliaments. He is deputy-lieutenant of Lancashire and Middlesex, for which counties he is also a J. P., as well as for Denbighshire, Argyllshire, and the city of Manchester. Sir John Pender has been twice married.—*The Electrician.*

THE MINIMUM POINT OF CHANGE OF POTENTIAL OF A VOLTAIC COUPLE.*

By Dr. G. GORE, F.R.S.

IN this communication is described the following very simple method of detecting the influence of the minimum proportion of chlorine or other soluble substance, etc., upon the electromotive force of a voltaic couple (*Nature*, vol. 38, p. 117).

Take a voltaic couple, composed of an unamalgamated strip of zinc or magnesium (the latter is usually the most sensitive), and a small sheet of platinum, immersed in distilled water, balance its electric potential through an ordinary galvanometer of about 100 ohms resistance by that of a precisely similar couple composed of portions of the same specimens of the same metals, immersed the same moment as the other pair in a separate quantity of the same water, and gradually add to one of the two cells sufficiently small and known quantities of an adequately weak solution of known strength in a portion of the same water of the substance to be used, until the balance is upset, and take note of the proportions of the substance and of the water then contained in that cell. In the present experiments a magnesium platinum couple was employed.

The minimum proportions required with several substances were as follows: Potassic chloride, between one part in 3,875 and 4,650 parts of water; potassic chlorate, between one in 4,650 and 5,166; hydrochloric acid, between one in 516,666 and 664,285; and with chlorine between one in 15,656,500,000 and 19,565,210,000.

The proportion required of each different substance is dependent upon very simple conditions, viz., unchanged composition of the voltaic couple, a uniform temperature, and employing the same galvanometer. The apparently constant numbers thus obtained may probably be used as tests of the purity or of the uniformity of composition of dissolved substances.

The "minimum point" varies with: 1st the chemical composition of the liquid; 2d, the kind of positive metal; 3d, to a less degree with the kind of negative metal; 4th, the temperature at the surface of the positive metal and at that of the negative one; and 5th, with the kind of galvanometer employed.

The order of the degree of sensitiveness is manifestly related to that of the degree of free chemical energy of the liquid; also to the atomic and molecular weights of the dissolved substances, and to the ordinary chemical groups of halogens. The greater the degree of free chemical energy of the dissolved substance, and the greater its action upon the positive metal, the smaller the proportion of it required to change the potential.

As the "minimum point" of a chemically active substance dissolved in water is usually much altered by adding almost any soluble substance to the mixture, measurements of that point in a number of liquids at a given temperature with the same voltaic pair and galvanometer will probably throw some light upon the degree of chemical freedom of substances dissolved in water.

* Abstract read before the Royal Society, June 14, 1888.

EFFECT OF CHLORINE ON THE ELECTROMOTIVE FORCE OF A VOLTAIC COUPLE.*

By Dr. G. GORE, F.R.S.

IF the electromotive force of a small voltaic couple of unamalgamated magnesium and platinum in distilled water is balanced through the coil of a moderately sensitive galvanometer of about 100 ohms resistance, by means of that of a small Daniell's cell plus that of a sufficient number of couples of iron and German silver of a suitable thermo-electric pile (see Proc. Birmingham Philosophical Society, vol. iv., p. 130), the degree of potential being noted, and sufficiently minute quantities of very dilute chlorine water are then added in succession to the distilled water, the degree of electromotive force of the couple is not affected until a certain definite proportion of chlorine has been added; the potential then suddenly commences to increase and continues to do so with each further addition within a certain limit. Instead of making the experiment by adding chlorine water, it may be made by gradually diluting a very weak aqueous solution of chlorine.

The minimum proportion of chlorine necessary to cause this sudden change of electromotive force is extremely small; in my experiments it has been 1 part in 17,000 million parts of water;† or less than $\frac{1}{7000}$ part of that required to yield a barely perceptible opacity in ten times the bulk of a solution of sal-ammoniac by means of nitrate of silver. The quantity of liquid required for acting upon the couple is small, and it would be easy to detect the effect of the above proportion or of less than one 10,000 millionth part of a grain of chlorine in one-tenth of a cubic centimeter of distilled water by this process. The same kind of action occurs with other electrolytes, but requires larger proportions of dissolved substance.

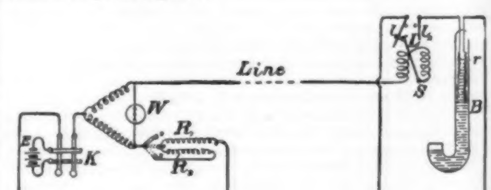
As the degree of sensitiveness of the method appears extreme, I add the following remarks: The original solution of washed chlorine in distilled water was prepared in a dark place by the usual method from hydrochloric acid and manganic oxide, and was kept in an opaque well-stoppered bottle in the dark. The strength of this liquid was found by means of volumetric analysis with a standard solution of argentic nitrate in the usual manner, the accuracy of the silver solution being proved by means of a known weight of pure chloride of sodium. The chlorine liquid contained 2·3 milligrammes or 0·03565 grain of chlorine per cubic centimeter, and was just about three-fourths saturated.

One-tenth of a cubic centimeter of this solution ("No. 1"), or 0·003565 grain of chlorine, was added to 9·9 c. c. of distilled water and mixed; 1 cubic centimeter of this second liquid ("No. 2"), or 0·0003565 grain of chlorine, was added to 99 c. c. of water and mixed; the resulting liquid ("No. 3") contained 0·000003565 grain of chlorine per cubic centimeter. To make the solutions ("No. 4") for exciting the voltaic couple, successive portions of $\frac{1}{10}$ c. c. or $\frac{1}{15}$ c. c. of No. 3 liquid were added to 900 cubic centimeters of distilled water and mixed.

I have employed the foregoing method for examining the states and degrees of combination of dissolved substances in electrolytes, and am also investigating its various relations.

ELECTRICAL BAROMETER.

THE object of this apparatus, by Johnson Stephen, is to enable the height of the barometrical column to be ascertained when the instrument is placed at a distance from an observatory. The general idea of the invention is not, we believe, novel, but the means by which it is carried out is decidedly new and ingenious. The principle of the apparatus is as follows, and is shown by the figure.



B is the barometer tube placed at a distance from the observatory station, and connected to the latter by a single line wire. Through the upper end of this tube the wire or carbon filament resistances, r, are inserted. These resistances dip down into the mercury, which short-circuits them, so that the actual portions of the wires or filaments offering resistance will obviously vary as the column of the mercury rises or falls. To determine, therefore, the height of the column, we have only to measure the resistances, r. In actual practice these resistances would measure about 5 ohms to the inch.

So far the arrangement does not possess any distinctive feature. To measure the exact value of the resistances, r, we must, of course, know accurately the value of the "line" resistance, as this must be deducted from the total measured resistance, in order to determine the value of r. Now, if the line resistance were a constant quantity, there would be no difficulty in determining r by a single measurement; but, of course, as is well known, the line resistance constantly varies, and it is the getting over of this point that constitutes the special feature of Mr. Stephen's invention. Connected in circuit with the line is a special form of automatic switch, S', which enables the line current to be diverted at the receiving end of the line from one circuit to another, as required, by causing the line current to pass in one direction or the other. The line current, it will be seen, passes through the magnet coils of the switch, and thence through a polarized armature, and then from the end of this armature to one or other of the two levers, l_1 l_2, according as the lever is over to the left or right; to effect which result the arrangement is such that contact is not broken from one lever until it is made with the other, so that the continuity of the line remains unbroken. The lever, l_2, is connected to

* Read before the Royal Society, May 3, 1888.

† As 1 part of chlorine in 17,612 million parts of water had no visible effect, and 1 in 17,000 millions had a distinct effect, the influence of the difference, or of 1 part in 500,000 millions, has been detected.

the barometer resistances, and the lever, l_1, to earth direct.

At the observatory station a Wheatstone bridge, W, is arranged with a double key, K. The adjustable resistance of the bridge is in two parts, R_1 and R_2. *s* is a three position switch; in position 0 this switch is disconnected, in position 2 it is connected to resistance R_1, and in position 3 to resistance R_2.

The working of the whole arrangement is as follows: The switch, *s*, being in position 0, the left hand pedal of the key, K, is depressed; this sends a current from the battery, E, direct to line, and actuates the switch, S', so that its armature moves over to the lever, l_1, putting the line direct to earth through the coils of the switch. The hand switch, *s*, is then moved over to position 1, and balance is obtained on the galvanometer by adjusting R_1. This resistance then will be the resistance of the line wire and the coils of the switch, S'. Switch, *s*, is then moved back to 0, and the right hand pedal of the key, K, is depressed. This causes a current to be sent, which moves the armature of S' over to l_1, thus putting the resistances, *r*, in circuit. Switch *s* is now moved to 2, and balance is obtained by adjusting R_2. Since R_1 is still in circuit, it is obvious that the resistance, R_2, must be the resistance of *r*, hence we get the value of *r* quite independent of the value of the line resistance.

It must be obvious that the whole arrangement is adaptable not only for the measurement of the height of a barometric column, but for thermometers as well, and indeed for several other purposes.—*Electrical Review.*

COMBINED MORSE INK WRITER AND SOUNDER.

AN exceedingly compact and well arranged combined Morse ink writer and sounder has recently been brought out by Mr. J. Ebel. Although the ordinary Siemens ink writer when working will usually give sufficient sound to enable the signals to be read by the ear, yet this reading cannot be effected with any degree of comfort, and the arrangement devised by Mr. Ebel, although possibly not the first of its kind, is certainly the best yet designed for the purpose, and is an exceedingly good example of a properly worked out mechanical combination.

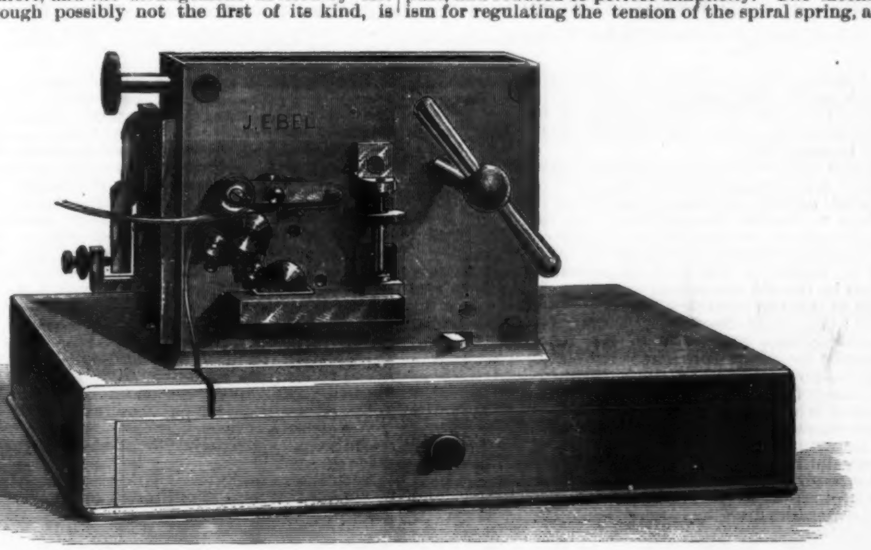


FIG. 1.

Fig. 1 represents a general view of the instrument. The position of the adjusting mechanism at the left side of the instrument is most convenient, being within easy and ready reach of the operator; and, moreover, the low position of the tape drawn by clockwork from the drawer enables a clear view of the recorded signals to be obtained.

Figs. 2 and 3 show sections of the electrical and mechanical arrangements of the instrument. The electro-magnet, E, is placed horizontally, and provided with a sliding arrangement and adjusting screw, M, to regulate its position with regard to its magnetic attracting power toward the armature, A.

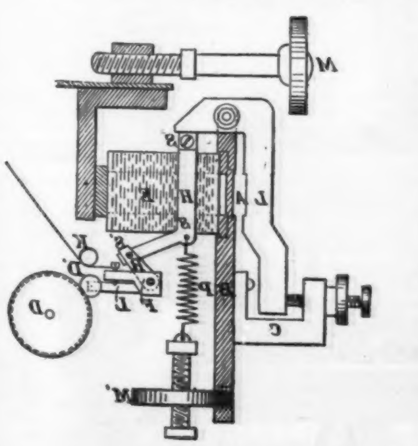


FIG. 2.

The lever, L, with the attached armature, A, is placed in a vertical position, and the "play" of its action is controlled by the contact points of the piece, C.

To produce clearness of sound in the signals, the piece, C, is attached to a wooden sounding board, B.

Through the medium of the metal piece, H (made of light flat steel), the lever, L, is connected with the spiral spring, P, at point, S and S', and further connected at S' with the pivoted axle, *a'*, by the fixed arm, R, the tension of spring, P, being adjusted by the screw, M'.

The inking disks, D and D', are arranged similarly to those of the Wheatstone receiver.

The small marking disk, D', is fixed on axle, *a*, controlled by the clockwork (not shown).

The axles, *a* and *a'*, are united through the light lever, L', without interfering with the freedom of movement in their bearings. Axle *a'* is provided with

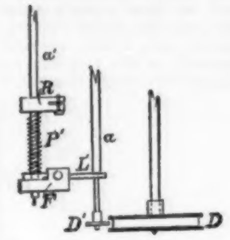


FIG. 3.

a fine spiral spring, P', fixed to the small lever, L, in such a way as to constantly draw the said lever, with its carrying axle, *a*, toward the arm, F.

The arm, F, is stationary, fixed to axle, *a'*, and provided with a small adjusting screw, which is so placed as to allow the marking disk, D', slightly to touch the tape passing under the stud, K.

The sound produced by the armature of the instrument is as equally clear and certain as with the best form of sounders; the ink writing mechanism is of very light construction, and is susceptible of very sensitive action, and in no way interferes with the production of sound. The form of the instrument is compact, and reduced to perfect simplicity. The mechanism for regulating the tension of the spiral spring, and for adjusting the electro-magnet, is of solid construction, and is placed in a more convenient position than has hitherto been the case.

The instrument is well adapted for portable purposes, and would be found suitable for field telegraphs.

It has already been adopted by several telegraph companies, and is said to give great satisfaction.—*Electrical Review.*

INTENSITIES OF LIGHT.

AT a recent meeting of the Physiological Society, Berlin, Dr. Koenig spoke on his measurement of the intensities of light in the spectrum. The method employed was as follows: A circular field of vision was divided into two halves, of which one was illuminated with some color of the spectrum of fixed intensity, usually with red; the color to be compared with this was then applied to the other half, and made to vary until it produced the sensation of a light-intensity equal to that of the red. The first measurements were made on Dr. Broddahn, whose eyes are dichromatic (green color-blind). By taking the mean of the separate determinations for different parts of the prismatic spectrum, Dr. Koenig had constructed a curve for the light-intensity of all the colors of the spectrum; there was a difference of at most 2 per cent. between the values of the separate measurements and the mean. The speaker then made similar measurements with his own normal trichromatic eyes; in this case he obtained a greater difference between the value of the separate determinations and the mean (up to 5 per cent.), but the curve of light-intensity for the whole range of the spectrum was found to be identical with that obtained from Dr. Broddahn. By reducing the prismatic spectrum used in these experiments to one produced by diffraction, he was able to calculate the curve of light-intensity for a normal spectrum. Comparing this curve with those which he had obtained in conjunction with Dr. Dieterici, for the sensations of the three primary colors, red, green, and blue (as determined for each point in a normal spectrum), he found that the curve of light-intensity of the spectrum was indentical with that for the sensation of red. From this it must be concluded that the sensation of luminous intensity for each separate light is simply dependent on the amount of red contained in it, or, to state this more accurately, the brightness of each kind of light is determined by the extent to which it stimulates the red-perceiving fibers of the retina. Dr. Koenig had some time ago given expression to the conjecture that in the dichromatic eye it is not the fibers for the perception of the third color which are wanting (the red-perceiving for red color blindness and green-perceiving for green), but that they are, so to say, differently tuned; tuned down in those who are color blind to green, so that they can only perceive the sensation due to light as red, tuned up to a higher pitch in those who are red color blind, so that when they are stimulated by rays of greater wave length they only perceive green. It is now possible to verify the above conjecture experimentally as follows: The measurements of luminous intensities throughout the spectrum were made upon the eye of another person who was color blind, and this time on one who was red color blind; in this case the curve obtained was identical with that of the sensation of green. The phenomena observed by Dove, that the relative luminous intensities of red and blue vary according to the intensity of the illumination, were verified by Dr. Koenig, but only up to a certain limit; beyond this limit, the *relative* luminosities of these two colors underwent no further alteration in the brightness of the illumination—Prof. Gad discussed Prof. Fick's views on blood pressure in the capillaries, which the latter believed he had placed on an experimental basis by means of an artificial vascular scheme; according to this, the pressure in the capillaries could not be much less than in the arteries, and only sinks appreciably as the capillaries are passing over into the veins. Prof. Gad showed that the conditions existing in the above scheme cannot be applied to the blood capillaries; he further pointed out that the requisite data for calculating the true blood pressure in the capillaries can be obtained from a theoretical consideration of the rate of flow in, and sectional area of, these vessels, and from this the pressure would appear to be about half of that which exists in the aorta. A true basis for any theory of capillary blood pressure can only be obtained from such experimental investigation as admits of being applied to various parts of the purely theoretical consideration.

STANDARDS OF LIGHT.

AT a recent meeting of the Society of Chemical Industry, London, Mr. W. J. Dibdin read a paper entitled "Standards of Light," in which he gave the results of a number of experiments made by many observers, which results had been compared with each other. He used a Sugg photometer; the room in which it was employed was kept at a constant temperature by means of a modified mercury thermostat set to 60° F. Pentane, as suggested by Mr. V. Harcourt, was considered the most trustworthy light-giving agent, and experiments had been tried with a mixture of air and pentane, burnt at the rate of 2½ ft. per hour, and giving the light of one average standard candle. He had also tried the Methven screen, in conjunction with a flame from coal gas charged with pentane; the slot was arranged to transmit a light equal to that of two standard candles, and the arrangement worked well. The 10-candle test devised by Mr. Sugg was also tried. The top of the Argand flame was cut off from view by a screen, so that the lengthening or shortening of the flame did not cause sensible variations in the amount of light used. With this arrangement Mr. Dibdin employed air charged with pentane; and found that the flame might be lengthened or shortened 2 in. without making any difference in the amount of light passing under the screen.

He then introduced to the notice of the meeting one of the little pear oil lamps now so popular on the Continent. The burner consists merely of a tube, in which the height of the wick is regulated by a screw, as in some cheap hand lamps in common household use. The wick is not consumed, and does not project above the level of the top of the tube. A little rod on the lamp holds a short horizontal arm of platinum wire at a given distance above the burner, and the length of the flame is so adjusted that its point just touches the platinum wire. The combustible used is acetate of amyl, better known as pear oil, and is selected because of its constant composition. In the photometrical tests, the flame of this lamp came out so well that Mr. Dibdin was for some time inclined to recommend it as the best of all the standards of light; but the color of the flame is too orange when compared with the whiter light of the other standards. The extra yellowness at first prevented some of the observers taking accurate readings, but this difficulty was overcome after a little practice. No other objection than yellowness of flame could be brought against the pear oil lamp, which, for simplicity and accuracy, was all that could be desired. He had not been able to obtain one of the incandescent platinum standards, but had experimented with a lamp in which the light was given by incandescent platinum. It consisted of a vertical plate of brass with a hole in it; behind this was a steatite screen, also with a hole in it, and behind this again was a movable strip of platinum foil, and behind the foil an oxyhydrogen blowpipe. In use, the instrument was viewed from the front, while the blowpipe flame was brought into play at the back, and at the temperature of melting platinum it pierced the foil. Mr. Dibdin said that this instrument was very simple, and was theoretically correct, but that after numerous trials he had had to abandon it for the present, because of the uncertainty of equally heating the whole surface of the platinum opposite to the aperture, also because of the buckling of the foil from rapid heating and cooling. These causes produced objectionable variations in the light emitted. All the standards of which he had spoken, the methyl acetate flame excepted, gave virtually the same spectrum, so far as practical purposes were concerned.

In testing by standard candles, variations in results were sometimes due to changes in the temperature of the testing room; but even when the temperature remained the same, candles were generally untrustworthy. They were not made of pure sperm, wax being added to "break the grain." He thought the best of the standards of light to be produced by the pentane air gas flame of Mr. Vernon Harcourt, but Sugg's 10-candle test gave wonderfully constant results.

In the discussion, Mr. Harris expressed himself in favor of a 16-candle standard, sixteen candles being the illuminating power of London gas, and in photometric work it was advantageous to have the conditions as much as possible equal on both sides of the central disk. Several other speakers addressed the meeting. One of them said that standard candles are often not made from the sperm oil of the whale of the southern

seas, but from the oil of the bottle-nosed whale of the northern seas, and that the latter oil is less luminous. Another speaker said that the variations depended more upon the wicks of the candles, which sometimes contained visible little particles of borax; in fact, an examiner could buy candles which will make the same gas indicate a luminosity of 16 or 18 candles, as he may choose beforehand. He did not see how the purity of various samples of pentane was to be readily ascertained, and thought that examiners should not be allowed to make their own standard gas. A third speaker believed that there were objections on geometrical grounds to the Methven screen, when used at shifting distances from the screen of a Bunsen's photometer; the principle of a cylinder of flame screened at the top was better. Another speaker remarked that a 3 in. flame from pentane vapor will give identically the same light, whatever may be the illuminating power of the coal gas passed over the pentane; even if pure hydrogen be used, the light is the same.

PHOTO-ZINCOGRAPHIC ENGRAVINGS.

MR. JOHN SWAIN, whose engravings are familiar to the readers of these pages, has several works in and about London for the production of various kinds of machine and lithographic prints, and that branch of his establishment which forms the subject of the present notice is at Farringdon Street. The process of photographing on wood blocks was taken up by him at an early date, before the advent of electric lighting, and foggy weather would then interfere seriously with rapidity of production, the printing process being much too slow for the utilization of the magnesium light; consequently, one misty day, when some engravings were wanted in a hurry for the *Illustrated London News*, he sent his son and a companion away from London by one of the lines of railway to the first place at which they could find bright daylight. They then left the train with the blocks and printing frames, took the required prints on the blocks, then returned by first train to London. This device is probably unique in all photographic experience. At the present time Mr. Swain is devoting much special attention to chromo-lithography of an artistic character.

At his photo-zincographic works in Farringdon Street the clean zinc plates are first coated with diluted albumen, and then with a solution of albumen in water, to

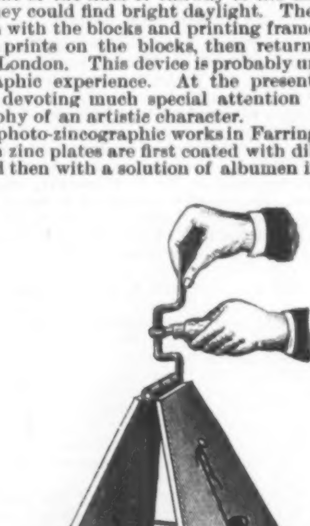


FIG. 1.—THE WHIRLER.

which some bichromate of potash is added. This is evenly distributed over the plate by means of the whirler, represented in Fig. 1; the zinc plate is placed faced downward in the jaws of the whirler, as represented in the cut. When face downward it is less liable to be deteriorated by particles of dust settling upon its surface, and the surplus liquid is removed with more facility. That the latter may run off all the more easily, the plate does not rest in grooves in the boards holding it, but upon the ends of nails driven through from the outside of each board. The plate is whirled, center-bit fashion, from fifteen to fifty seconds, according to the viscosity of the liquid used in any particular process. With diluted albumen the whirling is of short duration, and a perfectly even, very thin coating is obtained. In some works a whirler with a larger handle is turned by "knack" with one hand only. The operators in such cases fancy that the eccentric motion then also given to the plate is advantageous; but this is questionable. The wet solution of bichromate of potash, albumen, and water is not sensitive to light, but when the film is dry the reverse is the case. Hence the drying over a small gas jet is effected in non-actinic light. The effect of light is to partially deoxidize the bichromate of potash; an oxide of chromium insoluble in water is thrown down in the film, all the rest of which, where light has not acted through the negative, can be dissolved off in water. This process does not give half tones; it is suitable only for line drawings, or subjects in black and white.

The printing frames used by Mr. Swain are of a special description, and permit the application of much more pressure than those used in ordinary photography. One of them is represented in Fig. 2; its glass plate is an inch thick, and this is not in practice found to appreciably increase its liability to be cracked by the near proximity of the electric arc used in printing, perhaps because it is annealed with great care. In the cut the glass negative is represented upon the glass of the frame, and upon the negative is the zinc plate. Then comes the hinged back of the frame, with cross bars and strong screws for screwing all the surfaces together. When the plate is thus secured behind the negative, the frame is turned up, and the zinc plate exposed to light behind the negative.

When removed from the printing frame, the plate is inked, and washed for a few minutes to remove the bichromate of potash from the portions unacted upon by light. It next is treated with solution of gum arabic, after which the image upon the plate will take ink. It is under the gum solution for ten minutes, and is then washed. Afterward the plate is inked with a very greasy ink, and sent to the etching department, in which it is briefly immersed in a very weak solution of nitric acid, and then sent down to the artists' department, that any defects in the image, which are rarely present, may be removed by hand. It is then sent up stairs again for deeper etching. The image is inked by means of a perfected lithographic roller, with greasy ink, dusted with resin and heated on metal slabs, then the plate is put in baths of special Doulton ware, containing highly diluted nitric acid, and the baths are rocked by hand upon wooden cradles while the acid is eating into the metal. Every now and then the plate is taken out, inked, resined, and heated afresh, then replaced in the etching bath. This frequent varnishing of the image is given to prevent the

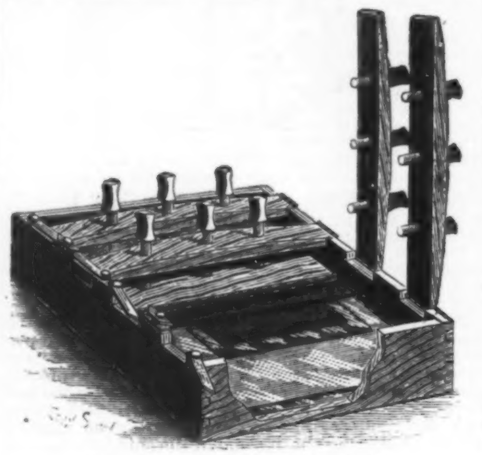


FIG. 2.—A PRINTING FRAME.

acid eating its way under the lines of the engraving, which under the system adopted stand up from the rest of the plate like little ranges of hills of exceedingly small elevation. An average plate takes about four hours to etch.

Nitric acid is used in the etching rather than hydrochloric acid, because it works quicker; and as carboys of nitric acid are unpleasant and somewhat dangerous things to handle in workshops, the carboy in use is mounted in the wooden frame—Fig. 3—in which it can be more conveniently manipulated.

The negatives for photo-zincography are usually taken by the old wet collodion process, as strong a contrast in them as possible of black and white being desired; but great density is of less importance than absolutely bare glass in the lines of the image. A good negative for the purpose, according to Mr. W. J. Wilkinson, an authority on the subject, should show all the lines of the image when it is laid down flat on a piece of white paper. When the lines are then quite clear, excessive density in the black is not so necessary as sometimes supposed. A few brands of the more slow gelatine dry plates in the market will do for photo-zincography, but the old wet process is more economical.

Fig. 4 represents a camera room, in which the maps and other line drawings are copied. The gigantic size of the cameras will be noticed; indeed, there is one among those on the premises in which a man can lie down. The lower camera, it will be noticed, is not pointed at the image. A box in front of the lens carries a mirror at an angle of 45 deg.; this mirror is silvered upon its face to get rid of double reflection, and its surface is optically true, that there may be no distortion of the image. The drawing is thus copied as it is reflected in a looking glass, in order to reverse the sides of the image upon the negative, on the same principle that the sides of drawings on wood blocks are in the reverse position to those which they occupy in prints from the same. In order to be independent

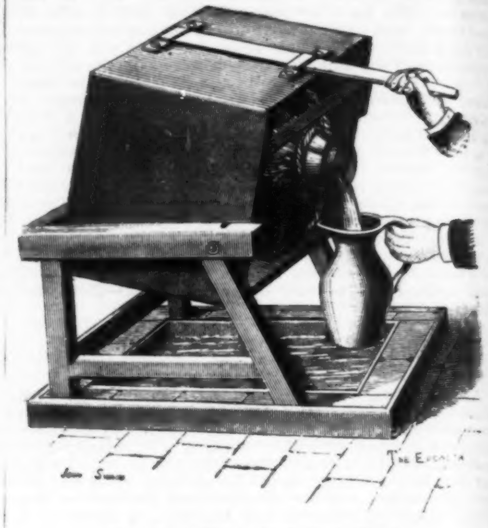


FIG. 3.—THE ACID POURER.

of the state of the weather, the photographing of the drawings is effected, when necessary, by the electric light. Arc lamps are used on the premises, a current of about 20 amperes and 35 volts being employed.

The intensification of the fixed negative, to make it deep enough for printing, is effected by Mr. Swain by means of ferricyanide of lead. His exact formula is not known to us, but Dr. Eder and Captain Toth, of Vienna, who discovered the method, proceeded as follows: The fixed and well washed negative received a washing with distilled water, then was plunged in a bath consisting of nitrate of lead, 100 grammes; red prussiate—ferricyanide—of potash, 5 grammes; distilled water, 5 grammes. In this bath it remained until it became quite white, then it was well washed, and flooded with a 20 per cent. solution of ammonium sulphide; when the film then became blackened through, it was thoroughly washed again, and the negative was finished. The smell of ammonium sulphide was strong in the photographic department at Mr. Swain's works.

The method of intensification used at Brussels in the production of negatives for Belgian ordnance maps gives intensely black negatives, and avoids the use of sulphide of ammonium. The agent used is bromide of copper. Where this process originated we do not know, but it came here from abroad. Early in 1877

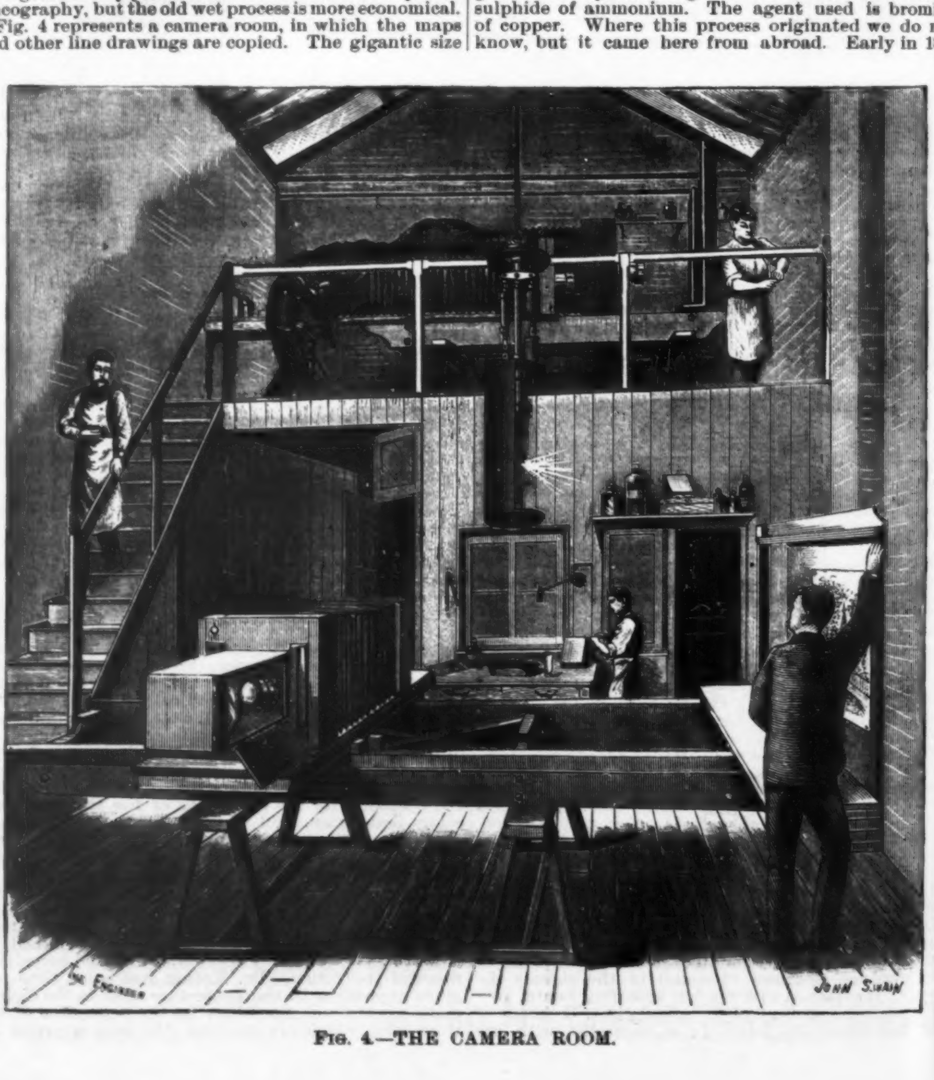


FIG. 4.—THE CAMERA ROOM.

Mr. Leon Warnerke saw the formula in *Anthony's Photographic Bulletin*, of New York. He then tried it, verified its merits, and communicated the results to Captain Abney, who also tried it, then read a paper upon the subject before the Photographic Society. By this method 120 grains of sulphate of copper are dissolved in 1 oz. of water, and 125 grains of potassium bromide are dissolved in as small a quantity of water as possible. The two solutions are then mixed, and the plate is flooded with the mixture. When the image becomes of a greenish-gray color, the liquid is poured off, the plate is well washed, then washed with distilled water, after which a solution of 100 grains to the ounce of nitrate of silver is made to cover it at one sweep. These operations may be repeated if necessary, but intense blackness is usually obtained by the first treatment. The only objection to this process is the considerable amount of nitrate of silver it uses up, but in all large photographic establishments the silver is finally recovered, so this process is much used. Mr. Warnerke found that the application of sulphantimoniate of soda in place of nitrate of silver gave a red image.

The power of Mr. Swain's works is obtained from two gas engines of 8 horse and 6 horse power. There are five dynamos on the premises. —*The Engineer.*

THE MANUFACTURE OF HYDROGEN.

THE chemical reaction which led to the discovery of hydrogen was also the one that the physicist Charles applied in the inflation of the first balloon. It consists in decomposing water by a metal (iron or zinc) which oxidizes under the influence of sulphuric acid and combines with the latter.

Charles' process has remained classic under the name of the cask method. As the name indicates, a certain number of casks were used for holding the iron filings, upon which acidulated water was poured. The first experiment of Charles was long and difficult, and it took four days to inflate his balloon, the capacity of which did not exceed 140 cubic feet.

Some years after this first and memorable tentative, when it became a question of applying aerostation to the art of war, it became necessary to think of manufacturing the hydrogen on the very spot where it was to be used. The cask method required a very cumbersome plant, and, at the same time, the reagents were not used to advantage. These two reasons justified the use of another process. Lavoisier had just hit upon the decomposition of water by passing it in the state of steam over red hot iron.

This was a laboratory experiment, and it became a question of repeating it on a large scale. Coutelle succeeded in devising an apparatus adapted for the purpose, and the experiment with it, tried in the presence of a committee of the greatest chemists of the period, was so conclusive that the process was at once adopted. Baron Salle de Beauchamp, in a work now very rare, gives a few details concerning this apparatus and the manufacture of hydrogen.

A large furnace of solid brick masonry was built *in situ*. At each extremity there were two fireplaces, the flames of which directly heated seven metallic tubes filled with iron filings that had been previously deoxidized.

After the tubes were filled, they were luted at the extremities and placed in the furnace, four below and three above, care being taken to consolidate them by means of bricks. Two or three sight holes permitted of the operation being watched.

At one side of the furnace there was a water reservoir, A (Fig. 1), and on the opposite side there was a purifier, C, designed to absorb the carbonic acid, and filled to this effect with a saturated solution of lime. After the preparations had been made, a quick fire was started in each of the fireplaces and the tubes were raised to a white heat. Then the communication with the boiler was opened, the water was decomposed in contact with the metal, which it oxidized, and the disengaged hydrogen passed through the purifier and gave up its carbonic acid therein, and finally reached the balloon, the inflation of which proceeded regularly.

The operation was a very delicate one, as the fire had to be kept up very regularly and be the same in each fireplace, and care had to be taken to see that the color of the metal did not change at any point. Finally, the fissures that quite frequently opened in the tubes were the object of minute and constant surveillance. They were easily recognized by the blue flame that proceeded from them, and an endeavor was at once made to stop the leak by the application of a luting; but the repairing was difficult and not without danger.

It took no less than from thirty-six to forty hours to effect the filling, and during this long and troublesome operation the balloonists found no time to sleep or eat.

The Cask Method.—This method consists in the decomposition of water in the presence of a metal (iron) and a proper quantity of sulphuric acid. The oxygen of the water goes over to the iron and oxidizes it, and thus permits it to unite with the acid to form a sulphate. The hydrogen then disengages freely.

The best method of proceeding is the one adopted by Henri Giffard for the inflation of the large captive balloon of the exposition of 1867, and by Dupuy de Lome in 1872.

The receptacles selected were 175 gallon casks, the top of which was provided with a wide aperture for the introduction of the iron filings, and another one for the introduction of the acidulated water, and a tube for the exit of the gas. At the bottom of each cask there was an aperture for drawing off the contents. Each cask received the following charge:

A permanent bed of iron filings		420 lb.
For each operation	water	935 "
	iron	68 "
	acid, 66°	136 "

In this arrangement, when the acidulated water is introduced, a violent effervescence occurs, but this gradually decreases in measure as the acid becomes weak and charged with iron sulphate. Each cask is capable of producing 440 cubic feet of gas, and it takes three hours to exhaust it. If, then, it were desired to inflate a 17,500 cubic foot balloon, it would require forty casks. Such a plant would be cumbersome and difficult to operate. In order to remedy such an inconvenience, the method of manufacture by successive batteries is adopted. Instead of forty casks, the *materiel* is reduced to twenty casks, grouped in two batteries of ten. The first battery alone enters into action in the first place, and thus gives 4,375 cubic feet of gas at the end of three hours. When it is nearly exhausted, the acidulated water is poured into the second battery, and, while this is in operation, the casks of the first battery are emptied and the iron that they contain is washed until the water comes off perfectly clear. Then the battery is charged again, and is ready to operate as soon as the other is exhausted.

The main drawback to this method is that it retards the inflation, this operation requiring twelve hours here, while with forty casks it takes but three. The method has the advantage, however, of reducing the plant, and this consideration is sufficient to compensate for the loss of time. It was used in 1872 by Dupuy de Lome, whose two batteries for inflating his large elongated balloon each comprised forty casks. In this case, as well as for inflating the captive balloon of 1867, the casks were arranged in two parallel groups, A A (Fig. 2). The acidulated water was led by a pipe, *d d*, on which there were branches to allow of its being distributed to the various casks through ajutages provided with funnels. The gas making its exit through the pipes, *f f*, was led by the collector, G G, to the washing and drying apparatus, H and I. A glass bell, J, containing a hygrometer and some litmus paper, permitted of seeing that the hydrogen was neither damp nor acid before entering the balloon.

The washing constitutes one of the essential parts of the manufacture, and must be watched with much care. The hydrogen makes its exit from the casks at a high temperature and saturated with humidity. The washing, in cooling the gas, has the effect of condensing the greater part of the aqueous vapor which the hydrogen contains, and which renders it heavy. This result may be enunciated under the somewhat paradoxical form—the more the gas is washed, the more it is dried.

Washing likewise frees the gas of solid impurities, and, at the same time, of a portion of the soluble sulphurous acid and sulphureted hydrogen formed during the reaction.

The arrangement for washing adopted by Giffard and De Lome (Fig. 3) consisted of a cylindrical vessel 5 feet in diameter and 5 in height. The cover was provided with a flange that entered a channel at the top of the cylinder. This channel being always kept full of water, a perfectly tight joint was formed, and one too that filled the office of a safety valve, since an excess of internal pressure could have no other effect than to expel the water from the joint. The gas pipe entered at the base of the cylinder, which contained a certain amount of continuously renewed water, of which the level was regulated by a waste pipe. The gas, escaping through

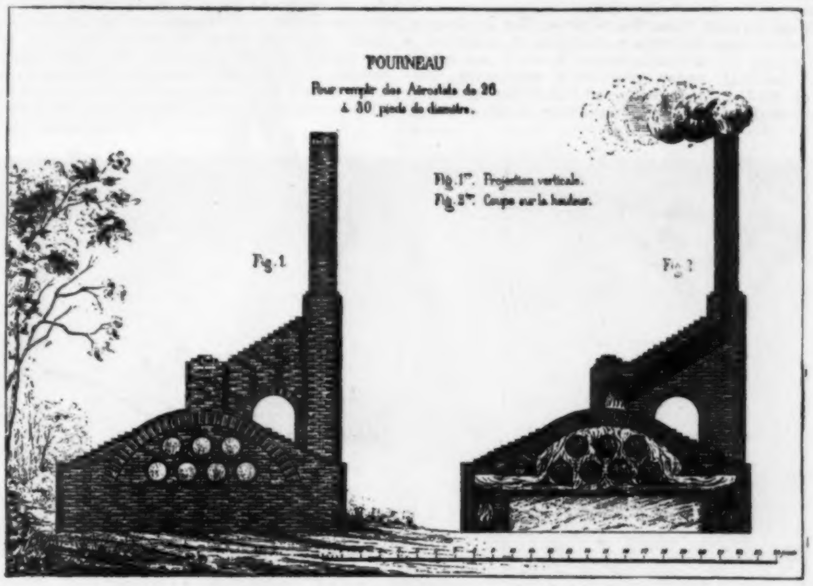


FIG. 1.—COUTELLE HYDROGEN PLANT.

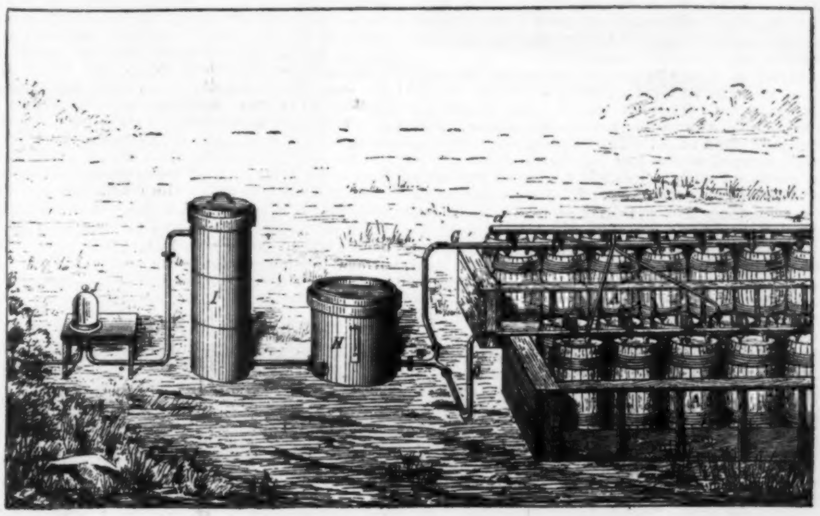


FIG. 2.—GIFFARD HYDROGEN PLANT.

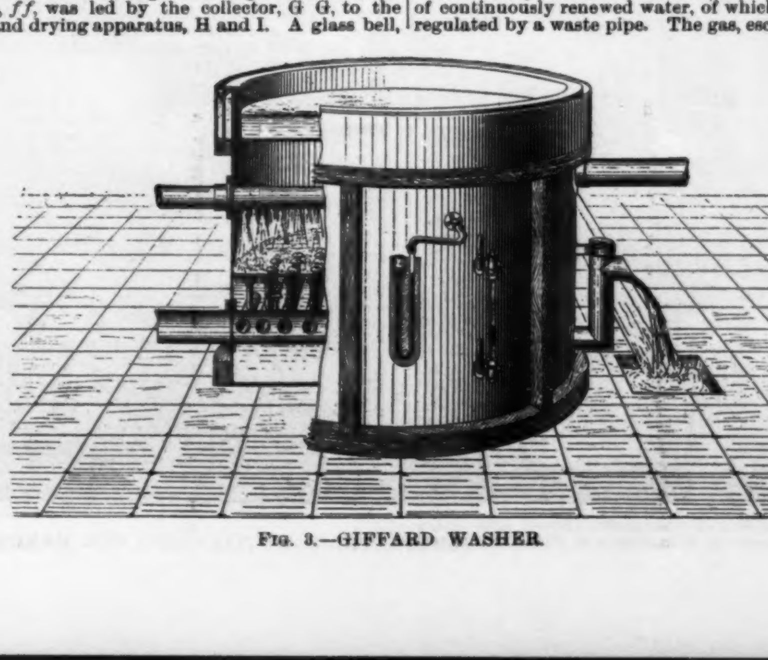


FIG. 3.—GIFFARD WASHER.

a number of small orifices, was forced to traverse 2¼ inches of water before reaching the upper part of the washer. The water was introduced through a tube containing a large number of small apertures, from which the liquid emerged in a spray, and thus finished the washing of the gas.

The washer and the drier were made of lead-covered iron plate.

On making its exit from the washer, the hydrogen, saturated with aqueous vapor, contains in addition a certain quantity of carbonic acid. Now, if we admit that the washing water reaches a maximum temperature of 30° C., the tension of the vapor in inches of mercury will be 1¼ inch. It may be easily concluded from this that the resulting weighting of the hydrogen, that is to say, the loss of ascensional force, will be but about ten grains per cubic foot.

It will be seen that, although the drier is a useful adjunct, its use is not absolutely indispensable, and that this apparatus may be much simplified.

In the Dupuy de Lome hydrogen generator the drier consisted of a large vertical cylinder 9 feet in height and 3¼ in diameter. This contained four grilles arranged one above the other and each covered with quicklime lying upon moss. The hydrogen entered at the base and escaped at the top.

The gas prepared with sulphuric acid and iron costs about half a cent per cubic foot. This cost can be decreased by collecting the sulphate of iron, which has some commercial value. This is what is done at the Chalais military establishment, where the water containing the sulphate in solution is collected in lead-lined vessels; but the construction of these crystallizers is attended with such an expense that it is justified only in establishments that are very frequently called upon to manufacture hydrogen.—*Revue de l'Aeronautique.*

THE MANUFACTURE OF GLASS.

The strike of the glass blowers at Pantin, which the proprietors of the glass works of the Seine and Seine-et-Oise have answered by a general closing of their establishments, is attracting the attention of the public to this important branch of our national industry, and, without occupying ourselves with a fight with which we have nothing to do, it has seemed to us that our readers would receive with interest the following details concerning the art, once noble, and at all times useful, of glass making. Without going back further, let us say that the Egyptians were skillful in the art of making glass. A fragment of a sculpture found in the grottoes of Beni-Hassan shows them occupied in the two most important operations of this manufacture. Their melting pots were very simple, and we shall see them directly advantageously transformed. On the contrary, were the mummy whose unwinding is described to us by Mr. De Goncourt to come to life, it might recognize in the blowing iron of to-day the iron tube that its contemporaries used. Forty centuries, in fact, have passed without the blower having done otherwise than inflated the ball of glass, attached to the end of his long tube, with his breath. Without speaking of the Greeks and Romans, who used glass so sparingly that it was kept at extravagant prices, let us note that the secrets of its manufacture were carried to Byzantium and thence to Venice. The Venetians obtained a few Byzantine workmen and founded the glass works of Murano, which acquired, and long retained, a just celebrity. With a more practical than moral sense of the prosperity of the most serene republic, the Council of Ten decided that the glass blowers who emigrated should have their property confiscated and that their relatives should be imprisoned. When this warning was powerless to bring the fugitives back to their country, an emissary was ordered to join them and put them to death—a somewhat strong measure, which, however, did not prevent the industry from passing over to Germany in course of time, then to Bohemia, and finally to France.

Let us now enter a modern glass works; let us start up the furnaces put out by the strike; and let us repeople the silent halls with a busy crowd whose cries mingle with the hubbub of the machines.

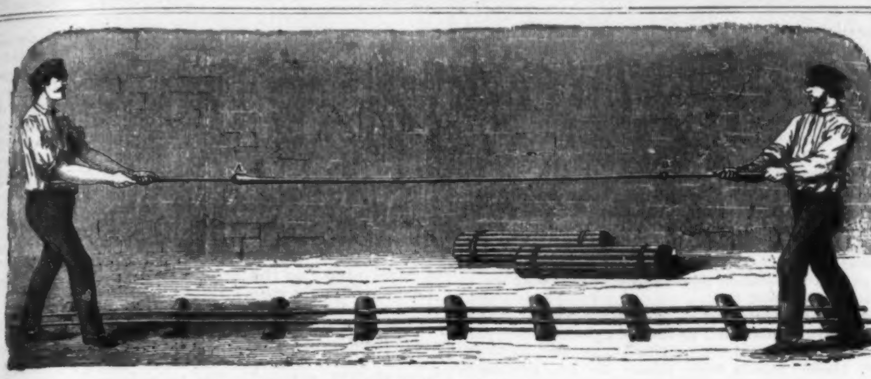
In the center of the hall, arranged in a regular polygon, the pots and furnaces melt and render malleable the delicate material that is constantly watched by the workmen who are to fashion it. When the glass has reached the desired degree of fusion, a workman, perched upon a platform that puts him within reach of the pot, and provided with a rabble, skims off the surface of the liquid glass. The scum is called glass gall, and has much analogy with the scoria of melted iron.

During these preparations, the stoker puts wet charcoal on the grate, for the temperature of the furnace must be lowered in order to keep the glass malleable.

A MODERN GLASS WORKS.

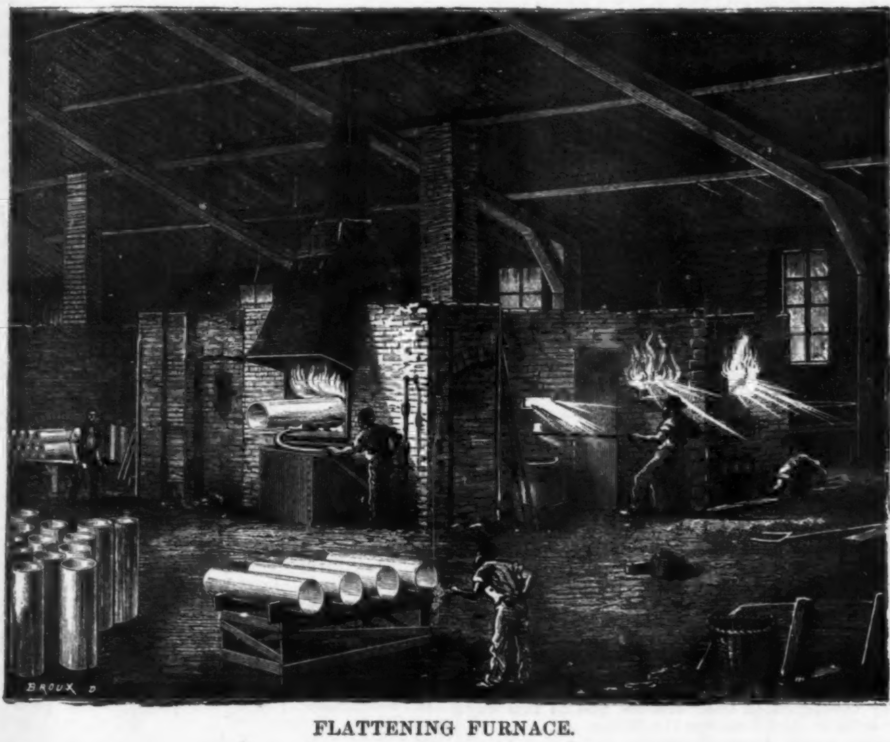
BLOWING A CARBOY.

MANUFACTURE OF CYLINDERS FOR MAKING WINDOW GLASS.



DRAWING A TUBE.

DRAWING OUT A TUBE.



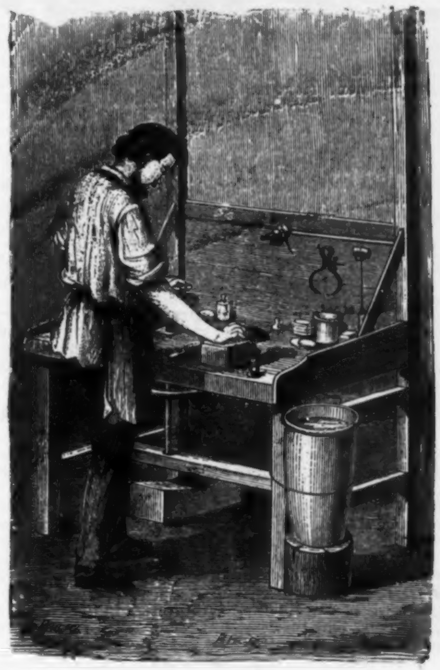
FLATTENING FURNACE.

MANUFACTURE OF BOTTLES.

An apprentice sweeps and sprinkles the place, in order that no dust may mingle with the glass.

But, attention! The glass blower is approaching the pot with a long blowing iron in his hand. This is a tube that terminates at one extremity in a sort of mouth piece, while the other extremity is expanded and of an elongated oval shape. The iron is covered for a portion of its length with wood. The tube is not less than three feet in length, and sometimes measures ten. The ordinary tubes are five feet in length and weigh about eleven pounds.

A glass blower has always from eight to ten irons, and he has to look after them with much care. The glass blower introduces the tube into the furnace through a small aperture that is luted with clay. When the extremity of the tube is of a dark red, the workman plunges it into the glass pot and takes out about six ounces of melted glass, which adheres to the inflated extremity. After turning and swinging the iron, the workman dips it into the pot again and



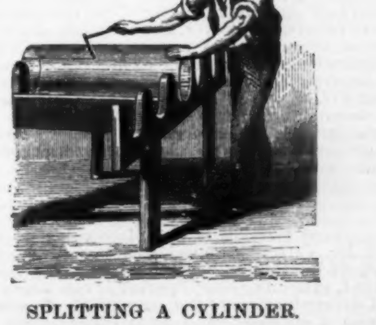
GRINDING EYEGLASSES.

collects more glass, and then blows into it in order to free the orifice, while a boy rounds the glass with a spatula. After several dippings, the mass of glass reaches the weight of eleven pounds.

The blowing now begins, and must be done promptly, especially with window and bottle glass, since this consists of materials not so carefully selected, and runs a greater risk of devitrification. When this accident occurs, the glass becomes "fibrous" (as the workmen say) and cannot be worked.

Placing the glass-covered end of the iron in a hollow block of wood that a boy keeps constantly wetting, the glass blower begins to convert the mass into a sphere. He stops, out of breath, but not in order to rest. When he is not blowing, he is swinging the glass globe around his head with a regular motion. He blows it anew, heats it for an instant in the furnace, and swings it around again until the right dimensions are obtained and the glass is ready to be detached.

The glass, separated from the blowing iron by means of an iron tool, is placed in the furnace and rapidly revolved until it assumes a cylindrical form. It is then



SPLITTING A CYLINDER.

placed upon a wooden support, the ends are cut off, and the cylinder is split lengthwise. The cylinder is now opened and flattened out. The window glass is made, and the piece thus obtained usually measures 44 inches in length by 28 in width.

All these operations, which have to be performed as rapidly as possible, take place in an atmosphere which sometimes reaches 40° C., and even 50°. We one day asked a glass blower how he was able to stand such a temperature. "Bah!" said he, "when one has taken a sweat, he goes out into the fresh air to dry himself a little and to get new strength by a good swig of cold water." This is an excellent recipe for pleurisy. Phthisis, along with asthma, is, moreover, one of the diseases with which glass makers are most commonly afflicted. It is true that the abrupt changes of temperature do not count therein for everything, and that the blowing has its share in it. Praise is due to those manufacturers who, through humanity as well as through a sentiment of their well understood interests, have had

their new works constructed in a more hygienic manner for their workmen. The upper part of the walls of certain halls is at present composed of strips of glass arranged (as at the Central Markets) in the form of Venetian blinds. The air circulates more freely in these establishments, and the men do better work.

MANUFACTURE OF WATER BOTTLE.

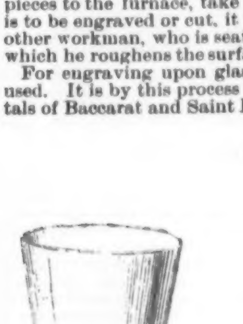
We have stated that the manner of blowing glass has not varied since the origin of glass making, the workman always having blown the piece with his mouth—sheet glass or bottle, large flask or goblet. Watch crystals themselves are not obtained otherwise. They are cut from an absolutely spherical ball of glass.

However, attempts at an improvement, precursory signs of a transformation that glass manufacture alone has escaped, were made and crowned with success two years ago at the Jeumont works in Belgium. A system of basin furnaces was applied, and is saving the glass blowers a very appreciable amount of strain.

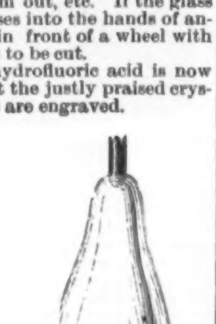
One operation of glass making that we regret to pass over in silence is that of the manufacture of goblets. These consist of no less than three parts—the cup, the shank, and the foot. These are made by three separate workmen.

A fourth workman puts them together and finishes the glass. All four are assisted by boys, who carry the pieces to the furnace, take them out, etc. If the glass is to be engraved or cut, it passes into the hands of another workman, who is seated in front of a wheel with which he roughens the surfaces to be cut.

For engraving upon glass, hydrofluoric acid is now used. It is by this process that the justly praised crystals of Baccarat and Saint Luis are engraved.



A FINISHED GOBLET.



SECOND FORM OF A GOBLET.

But, alas! a false movement, a slight and sudden gesture, may in a second destroy the delicate product of many efforts. However, less is broken since the discovery of the method of annealing glass. Numerous superintendents of factories at first looked with disfavor upon this innovation, and for a long time refused to apply it, saying: "If the breakage diminishes, we shall manufacture less." Neither the breakage nor the manufacture has diminished, and France continues to keep up her rank in the market of international glass manufacture.—*L'Illustration.*

DR. VETTIN'S WIND VANE.

AT a recent meeting of the Meteorological Society, Berlin, Dr. Vettin communicated the results of his observations on the daily periodicity in the velocity of the wind, extending over a period of two years. From direct determination of the movement of smoke coming from a chimney, and from observations with a home-made anemometer, he found that in addition to the well-known maximum velocity of the wind which occurs at midday, there is a second maximum just after midnight. This latter maximum is very small in summer, but in winter, on the other hand, it is much greater, and even exceeds that maximum which occurs at midday. This second maximum is not very marked as an average on the whole year. The speaker then gave a detailed description of the construction of his anemometer, which he exhibited to the society. He further described a spring vane which he had made, which he has erected at the window of his house in a moderately wide street; this vane indicates accurately not only the direction of the wind which is blowing up or down the street, but also of any wind which may be blowing over the houses at right angles to this. Experiments made with tobacco smoke in a glass-covered chamber have shown that the wind which blows over the houses gives rise to ascending and descending currents of air along their walls, causing an elevation or depression of the vane. The vane also records accurately the direction of a wind which blows at any angle other than at right angles to the axis of the street. Suitable as this spring vane is for observers who live in narrow streets, it is specially adapted for observations in narrow mountain valleys, in which the direction of the wind cannot be ascertained by any other means.

CREMATION.

AT the Anglican Free Church, Detroit, Bishop Jenner recently preached on the subject of "Cremation," taking for his text Daniel xii. 10: "Many shall be purified and made white."

In the selection of this particular passage for my text, he said, I have been governed wholly by its applicability to the subject before us, being fully aware that from a spiritual standpoint it has nothing whatever to do with it. But inasmuch as it is my present purpose to deal with this matter practically, as well as sentimentally, these words will prove to be, not only literally, but also essentially suggestive, as well as appropriately chosen.

In order, then, that we may examine this subject thoroughly, we shall consider it from a sanitary and sentimental as well as from a moral and religious point of view.

As a sanitary measure, the benefits to be derived from the universal adoption of cremation as a means for the disposal of the dead are not only innumerable, but also inestimable. I am fully convinced that the emanations from cemeteries and graveyards are the real though often unsuspected causes of nearly all the epidemics of common contagious and infectious diseases. And even when they are not the actual cause, such influences are undoubtedly instrumental in augmenting the virulence and increasing the fatality of all such visitations. These emanations pollute the air we breathe, they poison the water we drink, and even the very soil on which we build is contaminated by them. Centuries even will not suffice to destroy the virulence of contagion.

An instance on record shows that even after the lapse of several hundred years, "microzymes," or disease-producing organisms, were found to be alive and as active as ever, and became the cause of death to hundreds of workmen engaged in digging up ground which had been a burial place of some who had died of the plague of Modena, 300 years before. In fact, the plague was started anew, and so killed thousands more.

Many such instances might be adduced in support of the fact that in the absence of some specific germicide it is not only impossible to destroy the vitality of these pestiferous germs, but that they also increase and multiply for an indefinite period and to an almost unlimited extent.

THE SOIL OF CEMETERIES.

More recent researches have revealed the fact that the soil of cemeteries, even within a foot of the surface, often teems with these morbific germs, which are at once the cause and product of the disease of which the person died and whose body mouldered beneath. Irrespective of, and in addition to, these specific germs, there are the natural products of decomposition, which in themselves are not only disgusting, but also disease-producing. These matters, by permeation through the soil, pollute the air, and by percolation and infusion become dissolved or suspended in water, and so infect our streams and poison the water which we drink.

When you consider that the seething mass of corruption which is constantly going on only a very few feet at the utmost from the surface of a porous soil is continually breaking its fragile bounds and getting nearer to the surface daily, it is easy enough to conceive that the contagion emanating from a batch of victims of some by-gone epidemic, all of whom were buried at about the same time, and consequently may be supposed to have reached the same stage of decomposition, would simultaneously reach the surface of the soil, and by its concentrated virulence cause the outbreak of a fresh epidemic.

Furthermore, such a result would be very much aided by the practice, indulged in by so many people, of visiting cemeteries and sitting often for hours together by the graves of their dead. These people, though they themselves may escape disease, may, and often do, carry contagion in their clothes, and in this way sow the seeds of death among the living.

Cremation would, most effectually, put a stop to all this sort of thing, at the same time permitting a much closer communion with the dead by the presence of their ashes, ensconced in an urn which, of necessity, need never be out of the sight of those who mourn their loss.

This leads me to the consideration of this matter from a sentimental point of view. I am well aware that much popular prejudice exists against cremation. Many look upon it with a feeling closely akin to horror. This, however, can only be from a want of sufficient knowledge of the subject. For what is cremation, after all, but oxidation. That which, under ordinary circumstances, subsequent to burial, takes several years to accomplish, is thoroughly effected in an hour or two by the process of cremation; and if it was only possible minutely to watch the successive stages of both of these processes, not only would every shadow of doubt as to which of the two was preferable for the disposal of the dead immediately vanish, but every trace of prejudice would also vanish with the doubt.

Many people reject the idea of being burned, but cremation is not a mere process of burning, in the common acceptation of the term. A human body is not thrown upon the fire, in the same way that a piece of wood is thrust into a stove. Far from it. From first to last, the body never for a moment comes into actual contact with fire. On the contrary, every possible care is taken to avoid it.

WHAT CREMATION IS.

The process of cremation may be briefly described somewhat as follows: A cylinder is brought to a bright red heat. The body, wrapped in a fireproof sheet, is laid upon a fireproof bier, which is then rolled into the open cylinder, the door of which is immediately and securely closed. The body remains under the influence of this fervent heat for upward of an hour. During this very short interval it is reduced to a comparative handful of glistening and beautifully pure pearl white ashes. The diseased body, with all its disease-producing powers, has been reduced to its original elements and so restored to harmless purity. "It has been purified and made white." During the whole process, from first to last, there is absolutely nothing in any way disgusting or offensive to the senses, or revolting even to the most delicate sensibilities. The sole end and aim of cremation, as well as the process itself, is "to purify and make white." Whereas everything in connection with burial, from its first inception to its horrid termination, is disgusting in the extreme, and tends only to corruption and filth.

The ashes which remain after cremation may be gathered into an urn, as cheap or as costly as the pockets or tastes of the survivors may choose, and instead of remaining "in the cold, cold grave," the remains of their loved ones may be kept in the house, or in any other way be disposed of, as may be deemed fit.

Surely it needs no argument to convince any unprejudiced mind that from this point of view cremation is better than burial. The mere recital of the facts should amply suffice to remove every trace of prejudice from the minds of all but such as will not be convinced by any means, argumentative or otherwise.

A common objection against cremation, and one which is frequently urged, especially by the clergy, is that by resorting to it as a means of disposing of the dead we revert to barbarism. In answer to this, in the first place I must emphatically deny the sequence; and in the second place I affirm that, even if such was actually so, in this respect, as in many others, the manners and customs of barbarism are far superior to many of the ways of so-called civilization; and that in this very instance before us we should certainly gain by the reversion. Those people who resort to burning instead of burying their dead are usually impelled by some religious notion which embodies the idea of purification. At all events, by so doing they certainly employ the most effective and radical means of ridding themselves at once of the most loathsome and noisome of all impurities. Their mode of accomplishing this, however, may be open to objections; but, as I have before said, all such are entirely removed by the exquisitely perfect and scientific methods adopted in modern cremation. These over-religious people would do well to remember that under the Mosaic dispensation it was a capital offense to touch a dead body, or even a grave, unless an entirely irksome and tedious process of so-called purification was subsequently and thoroughly undergone. This fact, and many others of a similar character, may be gathered from Numbers, chapter 19, and following up the marginal references, which are very profuse. Moreover, they should also remember that fire was always regarded as an emblem of purity, and that equally with water, each in its proper place, was and is universally employed as a means of purification. And, from a sanitary standpoint, heat, a product of fire, is incomparably the best disinfectant and germicide as well.

But there is an objection, apparently real, existing in the fact that after cremation it would be impossible to discover either the evidences of crime or unnatural causes of death. But by the exercise of proper precautions before incineration, not only would the objection itself be removed, but detection and exposure would also inevitably follow. A post mortem examination prior to cremation would most effectually remove this objection. In short, from a sentimental standpoint there is not a single objection which can be raised against cremation which may not be categorically answered and removed.

Before concluding this part of the subject, however, it may be well to remind you that, by adopting cremation, burial alive, which is a much more frequent occurrence than is commonly supposed, would be rendered impossible. The preliminaries to cremation tend to restore animation in case of apparent death, whereas those which precede burial have an exactly opposite trend. And even if, after all, a spark of vitality should still remain, it would be imperceptibly and instantly extinguished when the body was submitted to fervent heat, whereas agonies untold have been endured by those who have been buried alive, as is proved by appearances when coffins have been opened. Finally, it may afford satisfaction to some to realize the fact that cremation most effectually prevents grave robbing and subsequent pickling, preparatory to dissection.

In conclusion, I shall supplement my preceding remarks by asserting that they are facts, and that they are no mere fanciful notions, fads, or imaginary evils, but horrible and terrible realities. I am no alarmist. Every sanitarian knows as well as I do that all that I have said is true. The developments of sanitary science and the researches of scientific men are daily adding fresh facts in support of this assertion. Therefore it is the bounden duty of every true sanitarian, and every godly person, irrespective of sex or sphere, not only to lay aside all personal prejudice, but also to aid with all their might in furtherance of this reform, and endeavor to convince the people at large of the enormity and widely spread nature of the evils resulting from burial. For all of these evils there is but one remedy, radical and unique, and that remedy is cremation, which, I am happy to say, is rapidly spreading even in those countries where not only the rites but also the places of burial are held in much greater reverence than they are here, where cemeteries and churchyards are consecrated and set apart for such purposes forever, and where vaults for the reception of the dead are often more carefully and securely constructed than are houses for the living. In such places the dead remain undisturbed for centuries, whereas in this country, where most of the burial places are either private property or that of a joint stock company, and consequently are liable almost at any time to be closed for such purposes, and converted to other uses, in which case, of course, the bodies have to be disturbed; and the consequences of such disturbance are simply incalculable.

Finally, and notwithstanding the existence of much misconception and unmerited prejudice, I am willing to believe that all will vanish, as the matter becomes more widely known and better understood. I am fully convinced, not only that cremation is the best, but that, ultimately, it will be the only means of disposing of the dead, in all civilized countries. Therefore, if in any way I can aid in hastening this grand result, I shall consider that I am doing my duty, not only to my neighbor, but also to my God, to whom be all honor and glory, henceforth and forever. Amen.

ELECTRIC ACUPUNCTURE.

ACUPUNCTURE was conceived by the Chinese at least four thousand years ago. They practiced it on an immense scale, and with all the complications that they introduce into the various arts which they cultivate. In the Chinese alcove of the National Library we have been shown a treatise, in three large octavo volumes, which speaks of nothing but acupuncture and moxa. This work, which has not yet been translated, is illustrated with very curious plates, from which we have made some selections. These show that the Chinese attached the highest importance to a large number of details that are trifling when it is a question of simple acupuncture, but that are worthy of consideration when it is a question of electric acupuncture, and an endeavor is made to localize currents transmitted for a curative purpose.

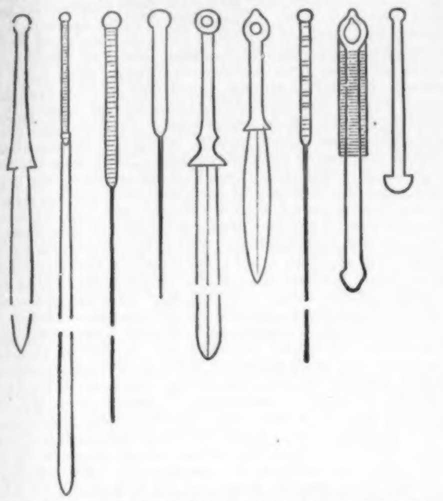


FIG. 1.—DIFFERENT FORMS OF NEEDLES FOR ACUPUNCTURE.

The Japanese naturally adopted this branch, like the other branches, of Chinese medicine, and have cultivated it with much ardor. History has preserved the name of a surgeon, Yoshida Ikia, who went to China in 1558 in order to study acupuncture, and who founded the school of Yoshidists. The object of these practitioners is not, like that of the electrical surgeon, to produce a tangible, specific action by means of the electrolytic power of the current, but to cause a flow of the "morbific principle." Consequently, the punctures diffe. in number and the place that they occupy.

The needles must be inserted to a determinate depth and have a proper direction with respect to the cutaneous surface perforated to allow of their introduction.

The Chinese and Japanese have conceived the happy idea of employing silver needles, and especially gold ones, which have the property of being inoxidizable, and very hard too, when they are very fine and are made of an alloy of which the composition is a trade secret. At Mr. Gaiffe's we have seen a $\frac{3}{10}$ mm. gold needle pierce a spruce plank.

In Japan, the manufacture of the needles is considered an art of the highest importance, because an endeavor is made to give strength to them merely by tempering, and without having recourse to chemical combinations that were not within reach of the Orientals before the recent founding of the University of Tokio. Before the last revolutions there was but a limited number of workmen, and these all had to obtain a license from the Emperor. We do not know how the ancient legislation has been modified in modernized Japan.

FIG. 2.—ELECTRO-PUNCTURE OF A TUMOR.

There are two sorts of models for the construction of the needles, which latter all have a length of about 10 cm. The first nave a spirally twisted head, and the second have a channeled one. The second are usually inserted in a copper tube of the size of a goose quill, serving as a conductor to the needle, which it allows to penetrate only to the depth desired by the operator.

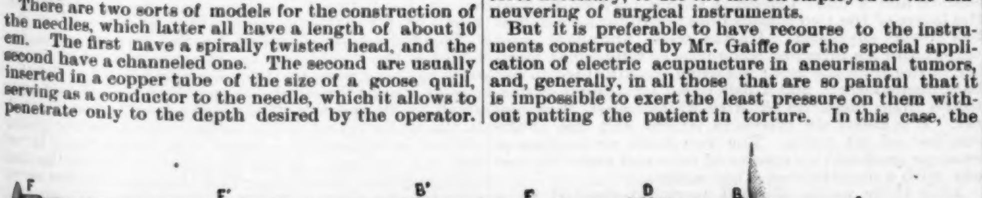


FIG. 3.—GAIFFE'S NEEDLE HOLDER.

A, needle in an arm, C, supposed to be inserted for its entire length. B, hollow button whence the needle emerges. B B', screw revolved before the operation, and so regulated that the length, B' D, shall equal that which it is desired the needle shall project. D, handle. E, graduation. F, head.

These instruments are carefully inclosed in a box lined with a soft fabric and sometimes having the form of a hammer, in which case the box serves for striking the head of the needle in order to drive it through the integuments. After this, the needle is revolved between the fingers until it reaches the depth at which it is supposed the morbific principle to be expelled is located. After the Chinese or Japanese physicians remove the needle, they compress it very strongly, in order, as they say, to evaporate the principle with which it became charged at the depth at which it was inserted. It is probable that to this superstitious idea must be attributed the multitude of forms adopted, and some of which are of such a nature that their introduction would inflict a genuine torture, were anything else done than a simple grazing of the skin with the majority of those figured in the Chinese work above mentioned. Out of the nine forms (Fig. 1), there are but three used in practice, the others being designed to figure in the outfit for acting on the imagination of the patient.

Acupuncture was not introduced into Europe until the end of the eighteenth century, and was not developed there till the beginning of the nineteenth, when it was practiced by Beclard, Demour, Bretonneau, Dance, and Cloquet, who studied it in all its details. The benefit that they claimed to draw from it did not sufficiently strike the public, and the method that they extolled fell into desuetude until it was renewed and regenerated by the processes of localized electrization that have given it a definite purpose in the hands of Drs. Semola, Meniere, and others. It is in use in the Henry Giffard clinic, directed by Dr. Darin.

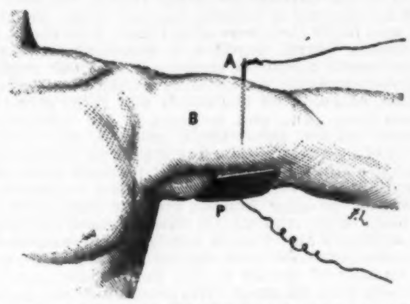


FIG. 4.—ELECTRO-PUNCTURE OF AN ARM.

A, entrance of the current. P, place of exit.

Of the needles employed by the Chinese, only those have been imitated which have a channeled head, and which may be used with a surgeon's forceps in order to insert them more rapidly. Precepts for performing this operation are given by Dr. Nelaton in his "Petite Chirurgie." One of them consists in revolving the needle backward and forward while at the same time pushing it, so as to prevent the tearing of the tissues and to allow the point to separate them. Another is to stick the needle into the skin simply and drive it in with a blow of a mallet. Another is to push it strongly. In this case it is well, in order to diminish the force necessary, to use the fine oil employed in the maneuvering of surgical instruments.

FIG. 5.—GAIFFE'S CLAMP AND SPECIAL NEEDLES.

A A', exposed metallic parts. B B', parts insulated with varnish. F, thread.

But it is preferable to have recourse to the instruments constructed by Mr. Gaiffe for the special application of electric acupuncture in aneurismal tumors, and, generally, in all those that are so painful that it is impossible to exert the least pressure on them without putting the patient in torture. In this case, the needle is placed at the extremity of an apparatus that may be compared to a crayon holder.

The arrangement shown in Fig. 3 permits of regulating the length of the instrument perfectly in advance, according to the distance of the organ to be reached, for true science must solve the problem that the gross superstition of Chinese and Japanese doctors proposed. There are likewise other very ingenious arrangements that eminent practitioners have proposed, and among these we may cite the one due to Dr. Boudet, of Paris.

In Fig. 4 we represent the arm of a patient submitted to an electrization, of which the localization is much more absolute than could have been obtained by any other process. Such a result, the importance of which cannot be overestimated, at least in certain serious cases, causes no other pain than that of a simple pricking, whatever be the depth of the lesion, that is to say, if the operation is well performed, and if, by means of the apparatus described, things are so conducted that the ailing parts are not submitted to pressure.

The needle must be varnished, in order to prevent the current from making its exit laterally, and to cause it to flow to the point. It is usually attached to the negative pole by a delicate thread. As for the positive pole, that terminates in a wide surface formed of a damp sponge. Sometimes it is desirable that the current shall make its exit laterally, and the point is then used only for fixing the needle in the tissues. In this case, the two ends of the needle are varnished, and the middle is left free (Fig. 5). These precautions are so much the more necessary in that it is not a question of circulating currents that give rise to simple physiological actions, but of effecting a radical extraction of tumefied parts.

The needles are extracted by means of an apparatus like a corkscrew (Fig. 6).

There are needles in the market insulated with rubber or glass, but it is easily seen that such a system is rude and imperfect, because it necessitates an increase of the diameter. In fact, all the wonder of acupuncture resides in the extreme fineness that may be given to the needles, and this is such that they can be inserted in the tissues without leaving permanent traces of their passage. When they are sufficiently fine, they not only cause no pain on passing through the muscular flesh, which is inert, but they separate the nervous fibers on their passage. They produce scarcely an appreciable sensation on entering the centers that are to be reached and submitted to the action of the current.

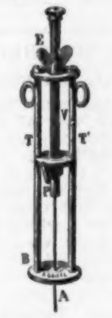


FIG. 6.—NEEDLE EXTRACTOR.

E, nut. P, needle clamp. V, screw. A, needle.

In general, it may be said that the rapidity of the operation is one cause of the suppression of pain.

Dr. Darin, who operated upon the writer, acted with so much rapidity that the entrance and exit of the needle produced but one and the same sensation.

When the needles traverse blood vessels, they must not be allowed to remain therein, as their presence causes clots; but if they are fine enough, they cause no hemorrhage. A drop of blood makes its exit, and the vessels immediately close as soon as the needle is removed.

Electric acupuncture can therefore be practiced without any danger and without recourse being had to anæsthetics. It may be employed not only in medicine, but also in the study of the vital functions. In fact, multiple experiments have proved that, with a fine enough needle, the heart of a vertebrate animal, such as a rabbit, can be traversed without killing the latter or causing it to give any apparent sign of pain.—*La Lumiere Electrique.*

TRANSPLANTATION OF NERVE FROM THE RABBIT TO MAN.

THE *British Medical Journal* has the following detailed description of Dr. Gersung's novel operation.

"Dr. Gersung, of Vienna, assistant to Professor Billroth, has recently performed a novel and interesting operation—the transplantation of nerve from the rabbit to man. Our Vienna correspondent has received from Dr. Gersung a verbal account of the salient points of this most remarkable operation, which has so far been conspicuously successful. The patient is Professor Von Fleischl, the distinguished occupant of the chair of physiology in the University of Vienna. Sixteen years ago he accidentally wounded himself while conducting a *post-mortem* examination, and severe inflammation of the whole right upper limb ensued. During the course of the disease the terminal phalanx of the thumb became gangrenous. The stump thus left was painful, and later on re-amputation was performed. This was followed by the formation of neuromata. For this condition the branches of the median nerve which supply the thumb were first resected, together with the terminal neuromata, and at a later period, when new neuromata began to develop, the central parts of the same nerves, together with the branches of the radial nerve which supply the thumb, were resected. Fresh neuromata now developed on the branches of the median nerve, which were treated, without any success whatever, by the injection of hyperosmic acid and electrolysis. Two years ago the neuromata were resected again, and the resection of the nerves was continued as far as the "ligamentum carpi volare;" on this occasion the branches which supply the radial and the ulnar sides of the index, as well as the radial side of

the middle finger, were resected to a great extent. The forefinger now became anæsthetic, except the dorsal side of its first phalanx, which, as was known, was supplied by the radial nerve; in the same way the whole radial side of the middle finger became anæsthetic. The pain, however, again recurred, as after the previous operations, and during the course of the second week, after the last operation, the patient became aware that a fresh neuroma was developing. The suffering finally became so severe that the patient wished to undergo another operation, in order to, at least, procure temporary relief. Accordingly, the following operation was performed: On March 4 the patient was put under the influence of chloroform, and the neuroma, which was situated behind the volar carpal ligament, was excised, the nerve being cut through behind the neuroma. The peripheral nerve stumps of the two digital branches above mentioned were then sought for. A rabbit was now killed, and as long a piece as possible of the schiadic nerve of the animal, with the two branches into which it becomes divided, was dissected from it (the animal still presenting voluntary contractions). The schiadic nerve was afterward inserted into the space between the central stump of the median nerve and its digital branches; the central end of the schiadic nerve was sutured to the connective tissue which covered the median nerve, and the two branches were sutured to the digital branches of the median nerve; the portion of nerve, measuring about six centimeters, which was deficient was thus made up. After the operation severe pain persisted for some hours, but then entirely subsided. Healing took place by first intention. As two months have now elapsed since the date of operation, and the pain has not returned, it may be hoped that the favorable result will become a permanent one. Sensibility, moreover, has become re-established in the part. Dr. Gersung has postponed the publication of the case because he wished to observe whether complete sensibility would return; he hopes with confidence that this will be the case. The ultimate result will be awaited with great interest, for if it is as favorable as now appears probable, Dr. Gersung's recommendation that the operation should be given an extended trial will doubtless be widely acted on."

[American Naturalist.]

SIX WEEKS IN SOUTHERN MINDANAO.

By J. B. Steere.

A three days' voyage from Puer to Princesa, in the island of Paraqua, by way of Balabac and Sooloo, brought us to the port of Zamboanga, in the southwest part of Mindanao. The harbor is of but little value. It is partly sheltered on the south by the low island of Santa Cruz opposite, but is open to the storms from the southeast. There had been a heavy blow from this direction before we arrived, and a high sea was running; but toward night we got our baggage into a huge dug-out, and were paddled ashore. After some trouble with the customs' officers over our baggage, we were finally, after dark, domiciled in a shaky old fonda, the only hotel the place affords, a liquor and tobacco shop and place for the sale of postage stamps and lottery tickets below, and a lodging place above. We got a promising view the next morning from our window into a yard below, where a dozen pairs of immense bivalve shells (*Tridacna gigas*) lay in the sun. A careful measurement of the largest pair showed three feet and five inches in length and two feet and five inches across the valves. They must have weighed toward two hundred pounds each, or four hundred pounds for a single shell. We found a single valve made a good load for two men. The Spanish naval officers, who seem, like other seafaring people, to be given to telling large yarns, tell of one off the south coast of Mindanao which has long been noted for its great size, and that the officers of the steam frigate Salamanca once planned to take it home as a present to Queen Isabella. They steamed down the coast until they found the shell, dropped their strongest hawser around it and put on all steam, but after some time found that instead of raising the shell the steamer was gradually sinking, being drawn under by the immense weight. So they cut the hawser and left the shell in its bed, where they declare it may yet be seen. The smaller species are found in the mud at low tide. Their toothed valves lie gaping apart, and must be traps ready set for any inquisitive monkey who may pass their way. The larger ones are found in deeper water, and there are stories of divers after pearl oysters being caught in their immense jaws and held to their death.

Zamboanga is a town of six or eight thousand inhabitants, nearly all Indian, but of mixed tribes, it having been a convict colony a generation ago, formed from the various islands of the group. The Spanish residents, twenty-five or thirty in number, are gathered, with the principal Chinese merchants, at the south end of the town, near the old stone fort and the church. The native town reaches down the coast to the north for a mile and a half, but is concealed in an immense grove of the finest coco palms. The houses are of the ordinary Philippine type—great baskets of nipa palm leaves, mounted on poles, eight or ten feet above ground. In front of a part of the native town is a village of Moros, Mohammedan natives, who may be the original inhabitants of the place. Their houses are of the same form as those of the Christians, but are poorer, and many of them built over the water, in true Malay style. These people seem to pretty nearly monopolize the business of boat making and fishing for the town, leaving the Christians to cultivate the soil.

Behind the city is a level country extending for three or four miles to the foot of the hills. Much of it is overflowed and planted to rice. The hills themselves showed patches of sugar cane and other crops, whose cultivation was crawling up their sides, but above and beyond all was still unbroken forest.

We made daily visits to the market, and found the Moro men, marked by their red turbans and tight-fitting drawers, busy selling fish, while their wives were squatted on the ground with little piles—one for a cent—of shell fish spread out before them. Among these were several species of spider shells in abundance, some fine cones and cowries, and great numbers of several species of bivalves: among them tree oysters, with fresh pieces of mangrove bark sticking to the valves, where they had chopped them loose with their knives. The woods being too far away to make general collecting easy from the city, after two or three days' stay we embarked in a native outrigger boat, and after three hours of voyage were landed on the grand beach of Ayala, a little town fifteen miles from Zamboanga to the north, where I had collected twelve years before. There being no house fitted for our use, we occupied with the officials of the place the tribunal, a large building near the church, and serving for jail, court house, town house, and lodging place for strangers. Coming up to the back side of the town and tribunal were the level rice fields, now flooded with water and just planted or being planted to rice. The woods had been cut back a good deal in the last few years, but we found the rice fields swarming with water birds, and concluded to stop for some weeks. The first trip to the fields produced eight or ten species of waders, and many more followed; sandpipers, snipes, plovers, rails, and herons, all in great variety. Many of them were no doubt migrants from the northwest, but several were breeding and no doubt residents. The population of the place seemed to be hunters by instinct, and as soon as they found that they could get grandes (the big old Spanish copper cents which make the small change of the islands) for living things, we were besieged by an array of helpers, big and little. Morning, noon, and night they were at our door, with shells, turtles, snakes, lizards, birds, and everything else they thought might tempt the coppers out of our pockets. The boys set snares for the birds about the flowers of the trees, and scoured the woods and fields with their bamboo blow guns, and brought in sun birds, forest thrushes, orioles, tailor birds, cuckoos, and even a number of small owls caught napping in the groves of second growth. Several old contraband guns were brought out, and with powder and shot advanced by us, some of the older hunters brought from the woods back loads of great hornbills, forest pigeons and jungle fowl, with now and then a big-footed mound-builder bird. One little old man, skilled in wood craft, set a large number of lassoes on the ground, and made us daily visits with his game. The most abundant ground-inhabiting mammal seemed to be a large spotted civet cat. One day he brought three of these, and then a black long-tailed animal as large as a cat, and of the weasel family. After these he brought us jungle fowl, colored like Spanish game fowls, and a few of the large ground pigeons with a bloody spot in the white breast, called by the Spanish *pemhalada*, stabbed with a knife. Whenever we could find time from our work of preparing the material purchased, we made visits to the forest, and added many species not found by the native hunters.

Two hollow trees inhabited by Galeopithecus were found and chopped down, and from one of these eight were captured, and there were others which escaped. They were old females, and young in all stages of growth, so that they would appear to breed the year round. We kept several of them living for some time, and had a chance to observe their habits. One specimen of the curious little tarsius was brought in. It is probably not rare here, but from its nocturnal habits not readily found. The common monkey, Cynomolgus, was very abundant and tame. We got two species of squirrel, the little *Sciurus philippinensis*, of a dark brown color, not larger than a mouse, but a true tree squirrel, with large bushy tail. Besides this we found a larger red brown one, which does not seem to be described. Besides those mammals mentioned we got a rat and a large shrew, making nine besides the bats. Deer and wild pigs were plenty, but we got none during our stay. Two crocodiles, six and a half feet long, but apparently adult, were brought in living, tied hand and foot, and were tied to a post in the open space beneath the tribunal. A large monitor, different in species from the Paraqua ones, was abundant, as was also a plant-eating lizard, of about the same size, four or five feet in length, and called by the natives ibit. It is called good food, like the plant-eating iguanas of South America.

Among the lizards was a flying one, *Draco*, abundant on the coco trees, and differing in size and color from those observed in Paraqua. On opening the wing membranes, one could not help noticing a likeness to a butterfly, both in shape of wings and in the coloring of nulattix blue with red spots. This case of resemblance must be added to the long list of cases of protective coloring. This peculiar coloring may aid the lizard both in escaping its enemies, the hawks, and in capturing its own food of insects. One evening one of our hunters came dragging in a python over twelve feet long and as thick as a man's arm, which he had met and shot in the path, and three snakes were brought in of several species, some of them venomous. Among birds we procured three species of horn-bills, all different from those of Paraqua—among them the great double-crested one, over a yard in length. These were found feeding in the wild fig trees at a height of one hundred and fifty to two hundred feet from the ground, and it tried all the shooting qualities of our guns to bring them down. They made the woods ring with their harsh cries of ca-la-o, from whence they got their native name. We found seven species of kingfishers, among them one apparently unnamed, and the rare spotted *hombroni*. We also found the species of broadbill Eurylaimus, supposed to be confined to Basilan. It inhabits different heights in the two islands, and a more extended search may prove that the fauna of the two islands does not differ as much as has been supposed. Hawks were abundant and varied, and we procured some nine or ten species, varying in size from the great sea eagle, closely allied to our bald-headed eagle, and a fish hawk equaling it in size, to the little black hawk with white breast, Microhierax. It is about six inches in length, and one of the smallest of its tribe. The rice fields and adjacent swamps produced six species of rails and eight of herons, with a multitude of other waders.

After three weeks of hard work, interrupted by a few days of fever with two of the party, we returned to Zamboanga with a collection of seven hundred specimens of birds, of some one hundred and fifty species, fifty mammals, seventy-five reptiles, and a few fish and amphibians.

After a visit to the island of Basilan we returned to Zamboanga and went north again, this time to a little bay called El Recodo, or La Culdera, about twelve miles from the city. We had heard that corals were abundant here, and were not disappointed. A gap between the hills, into which the sea entered, and then a long, low sand bar running out from one side and bending around, formed a quiet little bay, with deep water in the center shoaling on every side. Two or three hundred Moros had built low, tumble-down houses along the inner side of the sand bar and over the water, while two or three Chinamen, who had followed them for purposes of trade, had built homes on the inner side of the bay on the Aquala road. After getting settled in one of these houses, we took boats and paddled over to the bay. The water was very clear, and we could see plainly to a depth of twelve or fifteen feet. Most of the corals seem to grow above this depth, and most of the species here were within a few feet of the surface, and many of them exposed for some time at each tide. The quiet waters seemed to be especially fitted for the more delicate species of Madrepores, Pavonias, and Stylasters. Many of these would break of their own weight on being taken from the water. Scattered among the stems of the branching forms were a large number of species of Fungias. Near the shore were whole reefs of most delicate Madrepores and Millepores, which would break by dozens at each step as we waded over them, but the broken branches kept on growing, attached themselves to their neighbors, and the reef would be firmer than ever. As soon as the Moros found that we would pay for sea stones, they showed a greater desire for grandes than even the natives of Ayala had done, and there were soon a dozen boats over the bay coral fishing, while the women and girls were wading the reefs to find something that would suit our taste. In this way we got many species which would have escaped us. Even the chief of the village got out his boat, and diving down into about thirty feet of water, brought up specimens of a tree-like Oculina, with stems as thick as the wrist, and very heavy and jet black. He complained of a headache, but on being well paid tried it again next day. We bought and collected corals by the boatload and spread them upon the sand point to dry and bleach in the sun until we had a shipload, when we set to work to classify and select such as we could pack. We roughly estimated the species procured at this place at a hundred. Among the novelties was a curious little Fungia not larger than an old copper cent, but with the curious faculty of readily breaking into pieces, when each part would build itself into a disk again. Every storm would serve to multiply them. We found the packing a much greater job than collecting, but the villagers turned in and tore up cocoanut husks, and this, with rice chaff, furnished packing material of good quality. After two weeks of collecting, studying, and packing we returned to Zamboanga and took the next steamer for the Central Philippines.

THE RIVER DOCE, BRAZIL.

The Rio Doce, Brazil, an account of the exploration of which was recently read by Mr. W. J. Steains before the Royal Geographical Society, appears small when compared with the mighty rivers around it, yet has a length of rather over four hundred and fifty miles. Its head waters are several streams rising in the Serra da Mantiqueira, the loftiest peak of which, Itatiaiaassu, 10,040 feet, is the highest known elevation in Brazil. The various streams which unite to form the Rio Doce flow in a more or less northerly direction from the northern slope of the Serra and unite into a main river which, after receiving several tributaries, enters the ocean at about 19° 40′ south latitude.

The Serra da Mantiqueira has a general northeast direction, but the irregular line of the Brazilian coast range is continued northward by the Serra dos Amores, which is cut through by the Rio Doce in its descent from the interior table lands. The part of the Rio Doce basin lying east of the last named Serra is a densely wooded lowland, sloping upward to a height of about nine hundred feet, and resolving itself near the coast into a stretch of alluvial ground, studded with small lakes communicating by long winding streams called "valloes." The largest of these, the Lago Juparana, is eighteen miles long, and is connected with the Doce by a tortuous channel of about seven miles. It is fed by the Rio San Jose, a still unexplored stream, flowing through districts inhabited by wild Botocudos. The forests around it abound in the Jacaranda (*Bignonia cœrulea*), or rosewood tree. The Rio Doce is navigable as far as Porto de Sonza, one hundred and twenty miles from its mouth. Here occur the rapids which mark the crossing of the Serra dos Amores, and falls and rapids are abundant above this. There are, as yet, only three settlements—Linhares, Guandu, and Figueira—on the banks of the Doce, though for the greater part of its course grand virgin forests, filled with a hundred varieties of the choicest timber, come down to the water's edge in a wall of gloriously wild tropical vegetation. The valley is the home of the Botocudo, who has not yet renounced cannibalism. Mr. Steains does not place the number of these Indians at more than seven thousand, yet states that they form the sole barrier to colonization. Espiritu Santo, the province lying east of the Serra Amores, is at present the poorest province in the empire, and the valley of the Rio Doce is a great gap in the wall of civilization that has been slowly reared along the four thousand nine hundred miles of the Brazilian seaboard. There is not in Brazil a tract naturally richer than that which lies between the Doce and the Mucury to the north of it, yet the Indian is still in possession.

The Botocudos, so called by the Portuguese on account of the "botoque," or lip ornament, which is the only clothing worn by them, are about five feet four inches in height, broad chested and lean limbed, and with small hands and feet. The plug of wood is first inserted in the under lip when the Indian is three or four years old and is replaced by a larger until a diameter of three inches is attained. If the lip splits, the Indian ties the ends together with bark. The "botoque" is now worn only by the older members of the tribes. The nuts of two or three species of palm form the chief sustenance of these primitive people, and the supply is eked out with game and fish. Mr. Steains ascended the tributaries Tambaquary, San Jose, Pancas, and Rio San Antonio.

In the discussion which followed the reading of Mr. Steains' paper, Mr. C. Mackenzie stated that the custom of wearing an ornament in a slit made in the lower lip could be traced with very few breaks from the Eskimo of the Alaskan coast to Brazil.

[NATURE.]

HUNDREDTH ANNIVERSARY OF THE LINNEAN SOCIETY, LONDON.

THE hundredth anniversary meeting of this society was held on May 24 at Burlington House, in the library, the usual meeting room being inadequate for the reception of the large number of members present on this occasion. The president, Mr. Wm. Carruthers, F.R.S., took the chair, at three o'clock, and was supported by the two former presidents, who are happily still with us—Prof. Allman and Sir John Lubbock—the council of the society, and many distinguished fellows, among whom we noted Sir Richard Owen, Sir Joseph Hooker, Dr. Gunther, Sir Walter Buller, Prof. Duncan, Mr. Romanes, Colonel Grant, and among the visitors Dr. Henry Woodward, F.R.S., and Mr. Studley Martin, a nephew of the founder.

After preliminary business, H. M. the King of Sweden was elected an honorary member. The treasurer, Mr. Frank Crisp, laid the last year's accounts before the meeting, and briefly referred to the financial history of the society during the century now closed. The senior secretary, Mr. B. Daydon Jackson, presented an account of the Linnean collections from their formation, their purchase by the founder of the society, and their possession by the Linnean Society. This was succeeded by the president's annual address, which was largely devoted to a review of the society's past career. He spoke of the original quarto Transactions, then of octavo Proceedings, finally of the Journal, of which forty-three volumes are extant. During the past year seven parts of the Transactions and twenty of the Journal have been issued, an amount equal to that published during fifteen years in the early part of the century.

A novel feature was then introduced, one of those intended to mark the centenary of the society. Prof. Thöre Fries, the present occupant of Linnæus' botanical chair at Upsala, had been invited to pronounce a eulogium on his illustrious predecessor. As he was detained by his professorial duties in his university, his essay was read by the president. In it he spoke of the profound sleep of natural science during the middle ages, and the hard struggle which had to be fought before men of science could liberate themselves from a narrow orthodoxy or the fetters they had themselves forged by attaching infallibility to Aristotle and classic authors. Linnæus bore an honorable part in placing the study of natural science on a logical basis by his clear definitions and admirable nomenclature, and by the enthusiasm he was able to rouse in his disciples for the same methods. England, unluckily for Sweden, became his heir; many consequently are the ties which unite the memory of Linnæus with this country, the strongest perhaps being the Linnean spirit, the genuine spirit of freshness and enterprise in which scientific research is carried on in England.

Sir Joseph Hooker then pronounced a eulogy on Robert Brown, the greatest botanist of the present century. He specially dwelt on the evidence afforded by the "Prodromus" of his untiring industry, accuracy of observation and exposition, together with sagacity, caution, and soundness of judgment, in which he has not been surpassed. Where others have advanced beyond the goal he reached, it has been by working on the foundations he laid, aided by modern appliances of optics and physics. His memory was wonderful, he seemed never to forget a plant he had examined; and the same with his books—he could turn to descriptions for a statement or a figure without needing a reference. The noble title conferred upon him by Humboldt has been confirmed by acclamation by botanists of every country, "Botanicorum facile princeps."

Prof. Flower, C.B., F.R.S., delivered an address on Charles Darwin, who, he said, had special claims on their consideration, inasmuch as a large and very important portion of his work was communicated to the world by papers read before the society and published in the Journal. His life was one long battle against our ignorance of the mysteries of living nature, and he sought to penetrate the shroud which conceals the causes of all the variety and wonders round us. His main victory was the destruction of the conception of species as being fixed and unchangeable beyond certain narrow limits, a view which prevailed universally before his time. That other factors had operated besides natural selection in bringing about the present condition of the organic world was admitted even by Darwin himself. His work, and the discussions which had sprung from it, had marvelously stimulated research, and he had shown by his life and labors the true methods by which alone the secrets of nature may be won.

Prof. W. T. Thiselton Dyer spoke on George Bentham, who presided over the society from 1863 to 1874. A nephew of Jermey Bentham, and trained to some extent under him, he was early imbued with a taste for method and analysis, and through his mother's fondness for plants he was led to study them, with marvelous results. The records of his life work are astonishing. While president he delivered a series of masterly addresses, and the latter part of his career witnessed the preparation of the "Flora Australiensis" and a full share of the "Genera Plantarum." He stood in the footsteps of Linnæus, and although the descent was oblique, he inherited the mantle of the master whose memory was that day commemorated.

The president stated that the council had decided to establish a Linnean gold medal, to be presented to a botanist and a zoologist in alternate years, but on this occasion it would be awarded in duplicate. The medal bore on the obverse a profile of Linnæus, modeled from the bust in the library; on the reverse, the arms of the society and the name of the recipient. The president made the first presentation to Sir Richard Owen, recounting the chief services he had rendered to zoology. Sir Richard, with some emotion, expressed his high sense of the honor conferred, and thanked the fellows for their cordial reception of him. The president then presented a similar medal to Sir Joseph Hooker, with a like recapitulation of the splendid services he had bestowed on botany. Sir Joseph suitably replied, returning his cordial thanks for the distinction.

The remaining formal business included the announcement of the newly elected councilors and the re-election of the officers—Mr. Wm. Carruthers, president; Mr. Frank Crisp, treasurer; and Messrs. B. Daydon Jackson and W. Percy Sladen, secretaries.

The annual dinner was held at the Hotel Victoria, Northumberland Avenue, at seven o'clock. The president took the chair, about sixty of the fellows being present. In addition to the usual toasts, that of "The Medalists" was given, and replied to by Sir Joseph Hooker, who alluded to the fact that he had personally known eight of the presidents of the society, and that the founder himself induced his father, Sir William Hooker, to take up the study of botany. As a proof of his close connection with the Linnean Society, he added that his father, grandfather, father-in-law, and uncle had all been fellows.

The final portion of the centenary celebration took place the following evening, when the president and officers held a reception at Burlington House. A special feature was made of the Linnean manuscripts and memorials, which were displayed in glass cases with descriptions, a catalogue of them being also distributed. Memorials of other distinguished naturalists were also shown, conspicuously those of Robert Brown and George Bentham, lent by Sir Joseph Hooker and M. Alphonse de Candolle, of Geneva, a foreign member of the society.

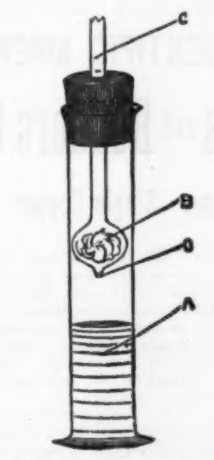
A SIMPLE FORM OF APPARATUS FOR GENERATING GASES.

By G. STILLINGFLEET JOHNSON.

THE apparatus most in vogue at present for generating such gases as CO_2, H, and H_2S is that of Kipp. The form of apparatus described below possesses certain advantages over Kipp's, notably on the score of economy.*

The construction of the apparatus will be best understood by reference to the accompanying diagram.

The bulb, B, is blown on a tube, C, and a small aperture is made at O. The solid substance is introduced into this bulb in small lumps (*e. g.*, marble, zinc, or ferrous sulphide) through the tube, C. The hole in the cork should be large enough to allow the tube, C, to slide easily in it on the application of a slight degree of force.



Cylinder A—Height, 6 inches; internal diameter, 1 inch.
Bulb B—Diameter, ¾ inch.
Tube C—Diameter, ⅓ inch; length, 8 inches.

The liquid by whose action the gas is to be produced lies in the cylinder, A. Now, if the tube, C, be pushed down until the bulb is immersed in the liquid, the latter enters the bulb through O, and generates gas by acting upon the solid in B. The gas escapes through C, and may be led by a delivery tube, joined by rubber tubing to C, into any vessel designed to receive it.

Many advantages which the apparatus possesses will be perceived on using it, but two may be pointed out here. The first is that, when a sufficient supply of gas has been obtained, the tube, C, may be raised till the bulb is out of the acid, when the action ceases.

The second is that the acid may be agitated at any time without disconnecting the delivery tube, thus avoiding cessation of action from spent acid adhering to the solid matter, which is one of the great disadvantages of Kipp's apparatus.—*Chem. News.*

* F. E. Becker & Co., of Maiden Lane, Covent Garden, supply the apparatus of the dimensions mentioned in the figure for the sum of 1s.

DETERMINATION OF TOTAL SOLIDS AND FAT IN MILK AND BUTTER BY MEANS OF WOODY FIBER.

By F. GANTTER.

THE author, instead of the paper proposed by Dr. M. A. Adams, uses, for absorbing the milk, "wood-stuff," as obtained by the wood sulphite process for the paper manufacture. It requires merely to be dried and extracted with petroleum ether in order to remove all traces of resinous matter. Two grms. of wood-stuff are placed in the capsule intended for the evaporation of the milk, along with a small glass rod, dried at 105° until the weight becomes constant, and weighed along with the capsule. During weighing the capsule should be closed with a well-fitting cover.

Of the sample of milk, which has been previously placed in a small phial, weighed and stoppered, 5 to 6 grms. are poured as evenly as possible upon the wood-stuff in the capsule, and the exact quantity taken is ascertained by reweighing the phial. The capsule is then placed upon the water bath, and care is taken, by stirring and pressure, that the wood-stuff sucks up all the milk, leaving the sides of the capsule scarcely moist. During the evaporation the whole is stirred occasionally so that no particles of the wood are left adhering to the metal. If at the beginning of the process small quantities of milk not absorbed are seen on the sides and the bottom, they are pressed and rubbed with the wood by means of the glass rod until the spot appears perfectly clean and bright. In an hour the contents of the capsule are dried up so far that the operation may be completed in the drying closet, which takes an hour and a half longer. The total solid matter is shown by the increased weight of the capsule. The dry matter thus obtained is inclosed in paper in the ordinary manner and placed in Soxhlet's apparatus.

STELLAR PHOTOGRAPHY.

By EDWARD S. HOLDEN, Director of the Lick Observatory.

ON the 16th of April, 1887, there was held at Paris an International Congress of Astronomers, at the invitation of the Paris Academy of Sciences.

More than fifty physicists and astronomers met for the purpose of considering a scheme of international co-operation in the work of making a complete photographic map of the whole heavens, from the north to the south pole.

This, at least, was the main object of the conference. A plan was perfected by which a number of co-operating observatories, working by similar methods and by instruments exactly alike, can in a comparatively short time obtain a series of photographic negatives which, taken together, will constitute a picture of the whole sky. We can thus hand down to our successors a perfectly accurate and complete record of the positions and magnitudes (brightness) of every star shown on the maps, and do our part toward solving many extremely important stellar problems. The ancients believed the starry universe to be "incorruptible" and unchanged.

We know, while the changes are relatively few and take place often with great slowness, that it is only by means of such changes that any new light is obtained on the extremely difficult problem of stellar constitution.

First we have to show that there are changes, next how these changes occur, and lastly why they occur. The maps are designed to show the circumstances of the changes, and it is left to the mathematical and experimental skill of the astronomer to explain the wherefore. But it is really the wherefore that concerns us. Our sun is a star; and upon the constancy of his light and heat all life on the earth depends.

What Stellar Maps we now Possess.—Thanks to the unremitting labors of Bessel, Argelander, Schoenfeld, Chacornac, Henry, and Palisa in Europe, and to those of Gould and Peters in America, we have star maps of the whole sky, which show the position and brightness of every star visible to the naked eye; of all the stars down to the 10th magnitude from the north pole to 23 degrees south of the equator; and down to the 12th magnitude over nearly all of a belt of sky 30 degrees wide and parallel to the ecliptic.

An idea of a 10th magnitude star may be had when it is said that a powerful marine spyglass will just about show stars of the 10th magnitude in the blackest nights.

History of Astronomical Photography.—For a complete history of astronomical photography, I must refer any one who is interested to some one of the sketches of this subject which have lately appeared. Perhaps one written by myself in the *Overland Monthly* for November, 1886, will be most readily accessible.

It is there related how the first daguerreotype of the moon was taken by Professor J. W. Draper, of New York, in 1840; the first of the sun by Foucault, of Paris, in 1845; the first of stars by Professor Bond, of Harvard College, in 1850; the first of a solar eclipse by Doctor Busch, of Koenigsburg, in 1851, and by Professor Bartlett, of West Point, New York, in 1854; the first photographs of the spectrum of the eclipsed sun by Professor Schuster and Mr. Lockyer, of England, in 1882; the first of a nebula by Doctor Henry Draper, of New York, in 1881; the first of the spectrum of a star by Doctor Huggins, of London, and by Doctor Draper, of New York.

It is interesting to note how large a share Americans have had in this progress.

Since the first successes, there has been an enormous advance in every way. The greatly increased sensitiveness of the modern dry plates has been a powerful aid.

The International Congress.—It has therefore been obvious for some time that photography was destined to play a considerable part as the servant or handmaid of astronomy, and the International Congress was called, in order to devise the best methods for co-operative work among astronomers all over the world.

The conference was attended by about fifty astronomers, and these gentlemen represented sixteen different countries, so that its conclusions may be taken as truly international, as well as authoritative.

The chief object of their deliberations was the determination of the means of making a complete survey of the whole heavens, by means of photography; and they also discussed the best methods of securing photographs of nebulæ, comets, star clusters, binary stars, planets, etc.

Their conclusions were formulated in resolutions, one of which reads thus: "To make a photographic chart of the sky for the present epoch, and to obtain the data for determining the position and magnitude of all the stars to the 14th magnitude."

The plates containing the stars to the 14th magnitude are to be taken in duplicate to guard against error. They must be made by means of special telescopes of thirteen inches aperture, and the exposure of the plates will be about fifteen minutes. The plates contain about four square degrees; and thus for every four square degrees in the sky, thirty minutes must be employed in the actual photographic exposures. Counting the necessary preparations and the time required to make duplicate plates to replace failures, we may reckon that for every plate of four square degrees photographed, the astronomer's time will be required for at least an hour, either in the observatory or in the laboratory. There are 41,000 square degrees in the whole sky, and therefore we must count on 10,250 hours devoted to this purpose alone, as the plates contain 4 degrees each.

With nights 10 hours long, there are 3,650 hours in a year. Everywhere but in California, Italy, and Algeria, about half of these will be cloudy; half of 3,650 is 1,825. Half of the clear nights will be unfit to work on such delicate photography, owing to the presence of the moon; half of 1,825 is 913 hours.

Leaving out of account every other possible source of disturbance, such as winds too strong to allow the steady pointing of the telescope, failure of the delicate mechanism by which the telescope is kept pointed at

the stars, twinkling of the stars themselves to a degree sufficient to destroy the accurately circular form of the star disks, and all other sources of failure and disturbance, there are thus certainly not more than 900 hours in a year in which such photographs can be taken. In my own opinion, 500 hours per year is a liberal allowance of available time. That is, 20½ years would be required for this work if it were done by a single observatory.

Probably ten observatories may be found which will join this co-operative work, and if this is so, a period of three years *may* suffice to execute this part of the work. As other work of the same sort is to be carried on in connection with it, it will in my opinion require at least six years before we are in possession of the two series of photographic charts proposed by the congress. The work is of such paramount importance that it is well worth this expenditure of time and labor, and so far as possible the Lick Observatory will join in it.

Besides the time spent in the mere observing, the time required for the necessary calculations and measures must be added; and it is likely that several years more will be required for this. If we have the completed work by 1900, we ought to be content.

The charts we have been speaking of are photographic pictures merely. But it was not necessary to call a congress of astronomers for the purpose of taking pictures merely. A congress of expert photographers would have sufficed for that.

Not only were these *pictures* to be made, but other photographs were to be taken in such a manner as to allow the most precise measures of position to be made upon them; and also in such a way that the relative brilliancy of the stars could be numerically expressed by data derived from the plates.

Roughly speaking, there will be about twenty million stars down to the 14th magnitude, and it is clearly impossible for *measures* to be made on the positions of so many objects. There are not enough astronomers in the world to do the requisite measurement and computation.

Hence it was resolved by the congress that "there should be a second series of plates of shorter exposure, to insure a greater accuracy in the micrometric measurement of the standard stars, and to render the construction of a catalogue possible." And it was therefore decided to make a second series of plates, giving the data for determining the absolute positions of the 1,500,000 stars down to the 11th magnitude.

The map of these 1,500,000 stars together with its accompanying catalogue will, so far as it is now possible to foresee, and so long as the methods of astronomy remain what they are now, forever answer the demands of astronomers for accurate star positions.

The maps of the 20,000,000 stars will, it would seem, give such pictures of the sky as will suffice to solve the problem of the existence of planets of our system exterior to Neptune, and to give all necessary data for the detection of new asteroids, new variable stars, and sufficient evidence to determine the real distribution of the stars in space.

Other Applications of Photography to Astronomy.—There are many other applications of photography to astronomy, and the conference covered these by a resolution which reads as follows:

"The congress expresses the desirability that there should be a special committee, which shall occupy itself with the applications of photography to astronomy other than the construction of the chart. It recognizes the importance of these applications, and the relations which it is desirable to establish between different kinds of work."

And accordingly a permanent committee was appointed.

It has been estimated that the sum of $20,000 is sufficient to purchase the instrumental outfit necessary, and to pay the necessary expenses of the observatory, and the salary of the astronomer to take part in the international undertaking of constructing the photographic charts of the heavens. This of course is a task which has a beginning, a middle, and an end. When it is finished, the instruments will still have very many useful applications of a different sort.

The whole question of making charts by photography is so recent that the Lick trustees did not include in their plan, by my advice, the purchase of one of the 13-inch photographic telescopes recommended by the Paris conference, in April, 1887. To have done so would have involved postponing the transfer of the Lick Observatory to the regents of the university (and hence postponing the beginning of its active work) for many months, and perhaps for several years.

Still, it is now known that this important work will be begun, and it is quite possible for the Lick Observatory to take a very active part in it, provided the necessary instruments are available, and an extra observer is forthcoming.

If any friend of astronomy will give us $20,000 for this purpose, I can promise for the observatory that it will engage in this international undertaking with vigor. And I think that it is quite safe to promise that our work will be done as well as any other. I am sure that we shall be able to finish our task more quickly than other observatories, owing to the continuous clear weather of our summer and fall months.

Photography at the Lick Observatory.—But the Lick trustees, acting on my advice, have provided a photographic attachment to the 36-inch telescope, which will enable this to be used as a gigantic camera for photography.

It cannot be used to make maps according to the scheme of the Paris congress, since that scheme requires a focal length of 10 feet, while ours will be 47. But we shall have a vast deal of work to be done falling under the resolution of the congress last quoted.

I have so far said nothing of the photography of the moon, of the planets, of nebulæ, and comets. Here the Lick telescope will have some important advantages. But it is in the photography of stars—of double and binary stars, of all the fainter stars, of all star clusters—that the Lick photographic telescope will find its chief application and demonstrate its immense superiority. One of the first works to be done is to photograph the vicinity of all the brighter stars, for the discovery of fainter companions, and for the permanent record of their surroundings. A certain number of stars will be selected and photographed at regular intervals throughout the year. Measures made upon these plates will give the data by which the distances of these stars from the earth can be determined. Similar measures upon photographs of star clusters may serve to give us a clew to the laws which govern the internal structure of these wonderful objects. A continuous series of photographs of the brighter parts of one of the brighter comets will certainly throw a flood of much needed light upon the process of their development.

It is not necessary to recount in detail all the various applications which astronomical photography may have at the Lick Observatory. It is plain from what has been said that there is no lack of important and interesting work close at hand, and that we already have definite aims for the work of the large telescope. In the course of doing the work already laid out many new and unsolved problems will arise, and we shall necessarily have to follow each of these to a conclusion. We also expect to be called upon in the future to help to decide similar questions which will arise in the practice of European astronomers.

To all of this work the Lick Observatory will bring unusual advantages both of climate and of equipment, and it is now certain that the liberal treatment of the observatory by the regents of the university will enable us to collect a company of astronomers and observers on Mount Hamilton, each of whom has already distinguished himself by his astronomical work, and each of whom may be relied upon to do earnest and creditable work in his new surroundings. It cannot be too often said that it is finally upon the faithful, intelligent, and uninterrupted work of the astronomers that the reputation of the observatory will depend.

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